BULLETIN No. 8
UTAH ENGINEERING EXPERIMENT STATION
DEPARTMENT OF METALLURGICAL RESEARCH
JUNE, 1916

PATENTS RELATING TO OIL-FLOTATION PROCESSES

BY

R. S. LEWIS and O. C. RALSTON

STATE SCHOOL OF MINES, UNIVERSITY OF UTAH
IN CO-OPERATION WITH
UNITED STATES BUREAU OF MINES

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Utah Engineering Experiment Station

The Utah Engineering Experiment Station was established by an Act of the State Legislature in March, 1909, as a department of the State School of Mines, the engineering college of the University of Utah. The station is authorized "to carry on experiments and investigation, pertaining to any and all questions and problems that admit of laboratory methods of study, and a solution of which would tend to benefit the industrial interests of the State or would be for the public good."

The following bulletins have been published:

Bulletin No. 1. Test of Utah Brick. (Out of print.)

Bulletin No. 2. Tests of Macadam Rock.

Bulletin No. 3. The construction and Maintenance of Earth Roads.

Bulletin No. 4. The Economical Design of Reinforced Concrete Beams.

Bulletin No. 5. Measurement of Flowing Streams. A Simple, Accurate Method of Using the Weir.

Bulletin No. 6. Leaching a Lime-Zinc Ore with Acids.

Bulletin No. 7. Results of Experiments on Sewer Pipe and Drain Tile.

Bulletin No. 8. Patents Relating to Oil-Flotation Processes in Cooperation with U. S. Bureau of Mines.

JOSEPH F. MERRILL, Director.

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PREFATORY NOTE.

In January of this year, the School of Mines and Metallurgy of the University of Missouri issued a bibliography on "Concentrating Ores by Flotation." Pages 55 to 90 of this bibliography contain an annotated list of the important British and United States patents arranged chronologically.

In making up the annotated list of patents given in this bulletin, the list given in the bulletin of the School of Mines and Metallurgy of Missouri was used as a basis. This list has been revised and enlarged, and although it is not entirely complete, it is believed to be more complete than any list hitherto published. There are many flotation patents that are buried in title and are only beginning to appear. Further, some of the patents in the list do not seem to be very closely related to the subject, but they cover ideas that might be applied to flotation processes.

These patents can be purchased from the Patent Office in Washington, D. C., at a cost of 5 cents each, and the whole set can be bound comfortably into two volumes.

This brief list is part of a more extended paper on the subject that is to appear later as part of a bulletin issued by the United States Bureau of Mines.

PATENTS RELATING TO OIL-FLOTATION PROCESSES.

By R. S. Lewis and O. C. Ralston.

The possibilities of the oil-flotation processes and the litigation that has arisen over the various methods of flotation has created widespread interest in the different patents that have been taken out on this method of ore concentration. The litigation has served to show that many very good ideas have been buried in the patent literature on flotation. There is now a tendency to dig them all out and test them in the light of present-day knowledge.

As long as flotation is such an empirical art as it is at present, every idea promising practical results will have to be tried, and experiments will subsequently have to be repeated if new facts seem to show that the first experiments should be performed under slightly different conditions. Thus every researcher in flotation is endeavoring to obtain patents on the subject in order that he can find new ideas or that his own thought will be stimulated. It is said that the patents of Mrs. Everson have been shown to be practical with present-day machinery, and her machinery is said to have needed only minor changes in order that she might have operated at a profit and made a success of her ideas. Later knowledge of oils and flotation machinery has allowed the application of her ideas almost in the whole. Such an illustration indicates why investigators are reviewing work done in the past.

Although the reading of the patents in their chronological order does not give the true history of flotation there is nevertheless a considerable story visible between the lines in the development of ideas that have resulted in the present-day successes of the process. On that account the patents are not classified but are given in the order of their appearance from the patent office.

207,695. September 3, 1879. John Turnbridge of Newark, N. J.

Separating metals from waste solution. A process for separating from water used by jewelers for washing, and from other water, the precious metals contained therein. The waste water is first subjected to a bath of oil or hydrocarbon oil, in order to separate the soapy matter contained in the water and to collect the mineral particles. The water, thus treated, is passed through a combustible filter, which is ignited and the metals collected.

244,569. July 19, 1881. P. H. Dunagan, Boulder, Colo. Apparatus for Recovering Precious Metals.

When saponine or a saponified oil or fat is brought in contact with precious metals suspended in water or other liquid, such as jewelers' and miners' waste water, a coagulum is formed that contains the precious metals. The water should first be settled to remove all possible earthy and non-metallic matter. If the water is soft or alkaline an addition of a salt or an acid is necessary to cause coagulation. The coagulum is then filtered through any vessel containing shavings, saw-

dust, grass, or the like; the filter is dried and burned and the metal is recovered from the ashes by melting in a crucible.

244,569. July 18, 1881. P. H. Dunagan, Boulder, Colo. Aparatus for Utilizing the Scum from Pulverized Ores. (Assignor to Aaron McCraw, Boulder, Colo.)

When pulverized ore is concentrated some of it floats on the surface of the water as a scum. This scum goes to waste, though it is generally rich in valuable minerals. Between the pulverizer and the concentrating machine, an apparatus, in the form of a rectangular settling tank, fitted with baffles, is provided through which the water is made to flow in such a manner that the floating minerals are caused to settle to the bottom of the tank, and are recovered.

251,718. January 3, 1882. A. E. Jones, Newark, N. J. Apparatus for Separating Gold from Quartz and Rock Tailings. (Assignor to himself, J. T. Rowland, and R. Gray, Newark, N. J.)

An apparatus for separating gold from quartz and rock tailings, comprising a tank containing a filter drum covered with wire cloth, so constructed that any fluid must pass through the filtering surface of the drum in order to escape from the tank. Above the tank, a broad endless belt or felt blanket is made to pass around a number of rollers, one of which presses the belt against the face of the filter drum. Any fibrous material that will form a pulp when mixed with water is placed in a mixing vessel from which it flows into the above mentioned tank. The ore tailing is ground in a pugmill, and after passing through a settling box whose function it is to catch all heavy lumps, the lighter part and the floating precious metal pass in to the tank, but on the side opposite to that where the fiber pulp enters. A paddle-wheel stirrer keeps the ore well agitated. As the drum revolves it first picks up the fiber pulp, which in turn catches the fine ore and gold, carrying it up until it comes in contact with the felt blanket. This blanket picks off the mineral-bearing pulp and carries it between a set of rolls which press out much of the contained water (the water being returned to the tank). The adhering pulp is now removed from the belt by a scraper and when a sufficient quantity has accumulated, it is burned and the gold extracted.

251,914. January 3, 1882. William Moller, New York, N. Y. Amalgamator.

An improved amalgamator in which the mixed pulp and mercury are subjected to the triturating action of revolving mullers. The amalgamating pan is provided with a discharge orifice, through which any floating particles of metal pass into suitable traps. In the traps are revolving cloth-covered rollers of sufficient diameter to extend above the surface of the water. The floating particles are caught on the surface of the rollers and are carried down into the mercury contained in the bottom of the traps.

267,351. Nov. 14, 1882. Alfred E. Jones, of Newark, New Jersey, assignor to himself, John T. Rowland, and Robert Gray, Jr., of same place. (Process of Collecting the Floating Precious Metal from Quartz or Cement-Rock Tailings.

Process of collecting and obtaining float-gold from quartz or cement-rock tailings which consists in, first, passing into such tailings a fibrous pulp, such as cotton or wool; secondly, withdrawing the fibrous material and the matter commingled therewith; next, pressing the water from the same; and finally, destroying the fibrous material.

268,325. Nov. 28, 1882. Elijah Warne, Easton, Pa. Concentrator and Separator for Ores.

Describes an improvement on a concentrator and separator for ores (Patent No. 258, 332, May 23, 1882). The improvement consists in deflecting the fine, floating mineral particles from the concentrator by a suitably directed stream of water, so that the float and any contained heavier particles first pass through a settling tank and then into a receiving box. In this box is a "skimmer" or launder so arranged as to carry off the surface stratum of water together with the floating material and convey it to a filtering box, where the solid material is caught on the filter cloth.

326,808. September 22, 1885. H. P. Tobey and G. B. Thayer, Boston, Mass. Ore Concentrator. Assignors to Golden Gate Concentrator Co., Boston, Mass.

A reciprocating ore concentrating table, provided with a separate feeding device in the form of a paddle wheel revolving in a trough. Pulverized ore mixed with water is fed in on one side of the trough. Any floating scum is caught by the paddle blades and carried down and around to the discharge opening on the other side. This opening is just below the level of the water. All particles are thus thoroughly wetted and are more easily saved by the concentrating table.

345,951. July 20, 1886. Hezekiah Bradford, of Philadelphia, Penn.

Method of saving floating materials in ore-separation consisting in passing the water and film of floating materials along in an open unobstructed sheet from the table or separating-machine with but little agitation of the water, thus preventing such materials from being carried beneath the surface and subsiding, then causing the water and floating materials to plunge or fall into a water receptacle, and then retaining said floating materials in said receptacle until they lose their floating power and sink. Merely a method of saving any film of floating minerals formed accidentally in ore dressing operations.

348,157. August 24, 1886. Carrie Everson, Chicago, Ill. (Process of Concentrating Ores.)

The Everson patent so often mentioned in litigation and adjudged to disclose the essentials of froth floatation. The pulverized

ore mixed dry with an oil amounting to from 5 to 17 per cent by weight of the ore. The dough of oil and ore is then "thoroughly agitated" in water to wash out the gangue and allow the oiled mineral to float off. No direct mention of a froth or foam is made, but the amount of oil is too small to allow of bulk oil flotation and directions to "thoroughly agitate" with water lead us to infer that air bubbles will be entertained in the oiled masses of sulphides.

373,113. November 15, 1887. H. J. Wagner, Dayton, Mo. (Churn).

A churn fitted with two spiral bladed dashers, revolving in opposite directions, and so designed that the cream is lifted from the bottom and thrown upward and outward in giving it a semi-circular motion, which is continually intercepted in every direction by counter currents from the oppositely revolving dasher, causing a thorough and equal agitation of the whole mass. In this movement air behind and under the blades, and oxygen of the air comes in contact and freely combines with every particle of cream.

379,418. March 13, 1888. J. Sandon, Virginia City, Mont. (Ore Concentrator.)

An ore concentrator for saving the valuable floating ore particles, consisting of a primary settling tank with a circular overflow launder discharging into an attached secondary settling tank. The primary tank is fed with ore by a launder fitted with a horizontal partition, the purpose of which is to separate the lighter floating portion from the heavier material and convey them to different parts of the primary settling tank. The light material passes to the top of said tank, thence through the discharge opening into the secondary tank, where it is first made to flow downward beneath the surface of the water through a passage fitted with baffles, and then up into the main part of the tank.

386,504. July 24, 1888. G. Sweanor, Kingston, N. M. (Method of Separating Metals from Quartz or Gangue.)

If finely pulverized quartz containing metal is placed in a vessel filled with water and a liquid insoluable in water and which is of greater density than water, but of less density than the quartz or gangue, the quartz, though of greater density than the insoluble liquid, will float on the surface of the liquid at the bottom of the water, while the metal particles precipitate through the insoluble liquid to the bottom of the vessel. Among the many liquids that may be used are: Carbon bisulphide, chloroform and oil of cloves.

397,585. February 12, 1889. J. D. Coplen, Denver, Colo. (Combined Separator and Concentrator.)

An apparatus for saving the floating values and slimes from ores, comprising a tank fitted with baffles so arranged as to cause the pulp to flow downward and then upward through the several compartments. The first compartment is used as a settler to separate the heavier and worthless gangue from the lighter material,

which passes on into the other compartments. In these it either collects at the top, where it accumulates until it becomes heavy enough to sink to the bottom, or it endeavors to pass into the next compartment along with the water, but is caught on a filtering screen, which permits only the water to pass through.

404,521. June 4, 1889. P. H. Dunagan, Denver, Colo. (Slime Separator.)

An apparatus for separating and saving the valuable slimes and float found in ores. The pulverized ore is fed into an inverted pyramidal shaped box, and the heavier portion sinks and is drawn off through a discharge opening at the apex of the box. A suitably actuated arm gives a gentle wave-like motion to the surface of the water in the box, thereby washing the floating minerals against the surface of a moving endless belt of wool fabric. The belt picks up the float and conveys it to a tank of water, where the material is removed. The removal is facilitated by a side shaking motion imparted to the belt.

414,962. November 12, 1889. H. J. Anderson, St. Louis, Mo. (Ore Concentrator.)

An apparatus for separating the precious metals from refuse ores, comprising a trough shaped receptacle which contains a liquid of greater density than the refuse ore, but of less density than the valuable minerals. The ore is fed in at one end of the trough, and, on passing toward the other end, the valuable minerals settle down through the liquid to the bottom of the trough. At suitable intervals, the liquid is drained from the tank. The minerals are retained on screens over the drain openings, and are easily collected.

444,345. January 6, 1891. E. R. Gabbett, Old Charleton, England. (Apparatus for Mixing Liquids). Assignor of one-half to S. B. Boulton, T. B. Haywood and H. E. Boulton, London, England.

An apparatus for mixing liquids or a liquid by the action of centrifugal force, whereby the liquid is continuously withdrawn from the bottom of the vessel and delivered at the top, or vice versa. This is the mixer originally used in the Cattermole process.

454, 116. June 16, 1891. J. S. Lurie, Kansas City, Mo. (Liquid for Separating Metal from Quartz).

Separating metals from ores by means of an artifically prepared liquid of greater specific gravity than the gangue, but of less specific gravity than the metals. The gangue is floated off, while the metallic particles sink to the bottom and are recovered.

461,425. October 20, 1891. F. M. Endlich, Ouray, Colo. (Ore Concentrator.)

An apparatus comprising a sluice along which the crushed ore and water pass and a belt carrying brushes at certain intervals, the motion of the belt being in an opposite direction to that of the water in the sluice. The height of the belt above the water is adjustable

so that brushes can be made to just skim the water or to pass along partly or wholly submerged. The brushes act as agitatiors and collectors, mechanically carrying the floating or suspended particles into proper receptacles

466,753. Jan. 5, 1892. Edgar A. Hockley, of Ouray, Colo. (Ore Slimer.)

An ore separator or slimer consisting of a receiving-tank provided with an inclined screw conveyor, a separating-tank provided with perforated pipes located at or near its bottom, and a stand-pipe connected therewith, said tank being provided with a top and bottom discharge, a vertically-movable gate provided with valves and floats, whereby the discharge of material from the tank is automatically regulated, and a suitable filtering-tank, the three tanks being arranged and connected substantially as and for the purpose set forth. This apparatus is designed to save floating films of such minerals as flour gold.

469,599. February 28, 1892. Albion M. Rouse, of Boulder, Colorado. (Method of and Apparatus for Separating Slime or Fines from Water Used in Milling Ores.)

Assignor to George R. Williamson, of same place. An improved method consisting in depositing the mill-tailing into a receptacle through which there is an upward flow of water, then carrying the water and tailing through a chamber, and causing an upward flow of air through the body of water and tailing, forming a scum of all the solids held suspended in the water.

471,174. March 22, 1892. Charles B. Hebron and Carrie J. Everson, of Denver, Colo. (Process of Concentrating Ores.)

A process for concentrating ores, which consists in first joining the metallic and mineral particles in the pulverized ore with a quantity of buoyant material, such as graphite, wool, sodium oleate, etc., and then sifting or blowing the prepared ore while in a dry state upon the surface of a liquid having an "effervescent condition" whereby the buoyed metallic and mineral particles are made to float and thus separate from the gangue, which settles. Probably equivalent to film and to bulk oil flotation.

474,829. March 17, 1892. Charles B. Hebron, of Denver, Colorado. (Process of Concentrating Ores.)

Assignor of five-seventh to Carrie J. Everson, of same place, Mamie W. Hutchinson, of Topeka, Kansas, and Charles T. Brown, of Chicago, Illinois. The dry ore is subjected to heat and vacuum to remove adhering gases from pores and surfaces of the metallic mineral particles, and then treated with a "stock" of buoyant material, the stock adhering selectively to the particles of such mineral. On presentation to a liquid surface the buoyed minerals float and the gangue sinks.

486,485. November 22, 1892. Axel W. Nibelious, of Hackettstown, N. Jersey. (Method of and Apparatus for Separating Graphite or Like Substance from Crushed Rock.)

The process of separating graphite and like substances from the crushed rocks, which consists in causing a falling body of dry and crushed rock to meet a vertically and upwardly moving body or stream of water at the surface of and within a surrounding body of comparatively still water, on which surface the flakes of graphite or other substance not absorbing water are separated and are floated off on the overflowing water, while the water-absorbing particles are precipitated in the water. Probably film flotation.

502,902. August 8, 1893. G. R. Evans. San Francisco, Cal. (Amalgamation of Precious Metals.)

Assignor one-half to B. Zehnder, San Francisco, California.
An improved process of amalgamation, whereby a mixture of lime, carbonate of soda and oil or other unctuous matter, is introduced into the amalgamating pan, with the result that the mercury is kept bright and clean, and is prevented from becoming floured and carried off.

521,899. June 26, 1894. J. W. Sutton. Chelmer, Queensland. (Process.)

A process for separating gold from its chloride solutions. An alkali, such as a saturated solution of borax, is added to the gold solution, then a hydrocarbon fluid, preferably a cheap mineral oil as kerosene. After agitation,the gold is precipitated by adding sulphate of iron. Dilute sulphuric acid is then added. Its function is to dissolve the iron precipitated by the alkali, increase the density of the solution, and free the oil so it can carry the precipitated gold particles to the surface of the liquid. The gold is recovered by filtering, be used it is not necessary to add the sulphate of iron, but the operation is facilitated by heating the solution, to about 180 degrees farenheit.

560,552. May 19, 1896. H. P. Tobey and G. B. Thayer, Boston, Mass. (Ore Concentrator.)

An improved ore concentrator having for its object the reducing of slime losses, by devices designed for the following purposes: First, to effect the preliminary removal from the mass of the pulp to be treated of the so-called "float" material; second, to lessen the amount of wash water required by removing the larger part of the upper layer of gangue by mechanical devices and to diminish the steepness of the inclined part of the ore bed whereon the washing takes place; third, to deliver the wash water required for the removel of the last traces of gangue in such a manner as not to disturb the fine material, as it approaches the upper part of the washing incline.

575,669. January 19, 1897. George Robson, of Dolgelly, England. (Separation of Metals and Metallic Compounds from Ores or Other Substances.) Assignor to himself, and Samuel Crawder, of London, England.

The method of recovering metals and metallic compounds from finely-divided ores, which consists in thoroughly and mechanically agitating and mixing a fatty oil of low specific gravity with said substances while the same are in a moist or platic state due to admixture of water therewith, then floating off the fatty oil, carrying the metal particles, and metallic compounds from the ores, and then separating the metals and metallic compounds from the oil. Bulk oil flotation.

577,825. February 23, 1897. J. H. McCoy, Ouray, Colo. (Apparatus for Treating Ores.)

An apparatus for saving the fine metalliferous particles from mill tailing. A series of inverted conical tanks are employed, each of which is provided with a bottom discharge pipe at the apex of the cone, and a feed and overfiow pipe at the top. The tanks are arranged in stepped order, so that a tank is slightly lower in elevation than the preceding tank, thus making the overflow from one tank the feed pipe to the next. By suitably arranged piping compressed air can be released in a number of small jets at the middle joint of each tank. When the feed reaches the first tank, the heavier particles sink and are carried out through the bottom discharge to be treated on vanners or other suitable machines. The lighter particles are carried upward by the ascending air bubbles and overflow into the next tank. The air pressure is graduated so that it is less in one tank than in the preceding one.

653,340. July 10, 1900. Francis E. Elmore, Leeds, Eng. (Apparatus for Separating Metallic from Rocky Constituents of Ores.)

An apparatus for bulk oil flotation utilizing 100 to 300 per cent of any thick or tarry oil of low specific gravity, in which the metallic minerals of the ore will be entrapped and floated. Probably the first commercially successful process.

655,338. August 7, 1900. Denis Gale, of Denver, Colo. (Apparatus for Separating Solid Bodies from Liquids.)

An apparatus for separating suspended solids from ore pulps by passing the pulp in a thin sheet over bodies of water in a series of chambers, allowing various sized particles to settle while others float off. Not truly a flotation patent.

667,222. February 5, 1901. J. W. Ivery, Dillsburg, Pa. (For treating Clay-like Material.) Assignor to E. Ellinger, Baltimore, Md.

A process for purifying clay or like material, by mixing with the clay an oil, soap, grease or gelatinous ingredient adapted to cause its

suspension in water, while the grit and foreign matters are precipitated. The suspended clay is then floated off, precipitated by alum or some ingredient having the same effect, and the precipitate is dried.

676,679. June 18, 1901. Francis E. Elmore, Leeds, Eng. (Process of Separating Metallic from Rocky Constituents of Ores.)

The process of separating the metallic from other constituents of ore, which consists in mixing gently with crushed ore to which sufficient water has been added to make a flowing mixture, a substance other than mercury, such as a thick oil of low specific gravity, to which only the metallic particles will adhere, separating by flotation, and then recovering the metallic particles from such substance. A so-called bulk oil process.

678,860. July 23, 1901. Henry Peareth Hawdon Brumell, of Buckingham, Canada. (Apparatus for Separating or Concentrating Minerals or Ores.)

In an apparatus for separating or concentrating minerals or ores, a vessel adapted to contain a body of still water, a water-supply pipe projecting into said tank below the water-level, said pipe being provided with a nozzle having a discharge directed toward a point of the end wall of the vessel intermediate between the water-level and the level of the nozzle, whereby a thin stream of water will be projected against said wall and deflected thereby across the surface of the body of water in the vessel to a discharge at the opposite end of the vessel, and a hopper adapted to deliver the dried material to be separated on to the surface of the stream of water. Minerals like graphite, molybdenite, etc., will float on the surface film.

679,473. July 30, 1901. John H. Davis, of Glens Falls, New York. (Graphite Separator.) Assignor to United States Graphite Company, of same place.

A water graphite-separator of trough-like construction, provided with means near the bottom of the trough for distributing the inflowing water to the machine; in combination with means for conveying the water and the graphite on the surface thereof in one direction and additional means for conveying the tailing in a different direction by the action of gravity and a part of the water; together with a horizontally disposed perforated partition located above the tailing-conveying means.

688,279. December 10, 1901. Alexander A. Allen, of Birmingham, Alabama. (Ore-Separator.)

The combination with a vessel arranged to discharge by overflow at one side, a broad inclined chute extending from said vessel to a point in said receptacle below the plane of discharge of the latter and arranged to receive the sheet discharged by said vessel and deliver it substantially unbroken in said receptacle, and means for placing upon the moving sheet discharged from said vessel a thin layer of material to be separated. Especially adapted to graphite.

689,070. December 17, 1901. Alexander Stanley Elmore, of London, England. (Separating Mineral Substances by the Selective Action of Oil.)

The process for separating metallic and rocky constituents of ore, which consists in mixing pulverized ore with water and gently mixing the ore and water with oil in the presence of an acid, allowing the mixture to rest, whereby the oil having the metallic substances entrapped in it floats at the top of the mixture, and separating the metallic constituents from the oil. Another bulk oil flotation patent in which the addition of an acid is all that is new.

692,643. February 4, 1902. Alexander S. Elmore, London, England. (Apparatus for Separating Minerals by Selective Action of Oils.)

The combination in an apparatus for separating metallic from rocky constituents of ore, of a trough, a shaft adopted to revolve within said trough, and provided with inclined blades, pipes for delivering ore and water to said trough, a subsidence-tank arranged at one end of said trough extending below the same and communicating therewith, said tank adapted to receive the liquid mineral pulp and oil from said trough, a vertically-extending partition arranged in said tank at the top thereof for the purpose set forth, a centrifugal drum arranged at one side of said tank, a pipe connected to said tank and communicating with said drum for discharging therein the metallic ingredients and the oil, and a pipe connected to the tank for discharging therefrom the earthy and rocky ingredients.

696,739. April 1, 1902. J. Klein, Desloge, Mo. (Ore Classifier.) Assignor two-thirds to P. A. Fusz and C. D. McLure, of St. Louis, Mo.

An ore classifier in the form of a cone shaped tank, with a top overflow around one-half of the periphery of the tank, and a horizontal discharge pipe near the apex of the cone. Two other pipes are connected to the classifier: one, a vertical air pipe at the apex of the cone; the other, an inlet pipe for water placed opposite to the discharge pipe. An agitating device, consisting of flanged arms at the end of a suitably operated vertical shaft, is provided. The light particles in the ore pulp are carried up by the ascending air bubbles, the heavier particles on sinking are carried into the discharge pipe by the jet of water from the pipe at the bottom.

703,905. July 1, 1902. Alexander S. Elmore, London, Eng. (Apparatus for the Separation of Minerals by the Selective Action of Oils, etc.)

An apparatus for affecting separation of minerals by the selective action of oils and like substances, the combination of a stepped incline for downflow of the mixed pulp and oil, with a traveling oiled apron arranged over and in suitable proximity to the said stepped incline for downflow of the mixed pulp and oil. This apron collects the oiled sulphides which are later removed.

709,593. September 23, 1902. D. C. Boley, Chicago, Illinois. (Treating Pulverized Ore.) Assignor to H. Block, Pekin, Ill.

An apparatus for treating finely divided ore by filteration, being a combination with a revolving filter surface, of means for creating a vacuum beneath the filter as it passes a portion of its course, and a means for producing, at a different time, an air pressure backward through the filter.

725,609. April 19, 1903. John W. Wolf, Randolph, Iowa. (Aparatus for the Recovery of "Flour" Gold by Bulk Oil Flotation.)

The crushed ore is saturated with kerosene, or other oil, and fed into a tank of brine thickened with clay or earth and covered with a layer of oil. The gold stays in the layer of oil, whose density is much less than that of a strong brine.

727,974. May 12, 1903. J. Klein, Desloge, Mo. (Apparatus.) Assignor one-fourth to P. A. Fusz and C. D. McLure, of St. Louis, Mo.

An improved ore classifier consisting of a receiving hopper for the ore, with air pipes, fitted with a rotary pulsating valve, and water pipes discharging into the hopper. The action of the air and water serve to agitate the mixture and cause the sludge and lighter particles to be carried out through an overflow trough. The heavier material settles to the bottom of a 'classified ore chamber, connected to the hopper, and passes from there to an amalgamating pot adapted to receive small particles of gold.

729,805. June 2, 1903. J. & L. Stoveken, Cripple Creek, Colo. (Apparatus for Extracting Metal from Ores.)

An apparatus designed for the treatment of low grade, clayey ores, whereby the ore is reduced to a finely divided state in the presence of a solvent. A series of tanks containing means for agitating the ore and solvent, and a filter adapted to separate the solution from the ore.

734,641. July 28, 1903. Charles F. Wheelock, Birmingham, Alabama. (Ore Separator for Film Flotation of Graphite.)

The combination of a vessel adapted to be filled with water and provided with means for precisely determining the level of the water, a chute declining toward and adapted to reach said level; a transverse waterpipe slightly below the water-level, approximately parallel with and in proximity to the discharge edge of the chute and discharging laterally in the same general direction as the chute; means for delivering water under pressure to said pipe; means for regulating said pressure; and means for causing a thin, uniform stream of dry graphite ore to descend the chute.

735,071. August 4, 1903. Guillaume D. Delprat, Broker Hill, N. S. W., Australia. (Extraction of Zinc, Lead and Silver Sulphides from Their Ores.)

The method of separating ores from gangue, which consists in forming a bath containing nitric acid, feeding finely ground ore thereto,

whereby gas bubbles will be formed on the sulphide particles to raise them to the surface of the solution, and removing the particles of ore so lifted to the surface. Heat to be applied if necessary. No oil is used.

736,381. August 18, 1903. Moritz Friederich Reinhold Glogner, Frieburg, Germany. (Process of Purifying Graphite.)

A process for purifying graphite in a wet and cold manner by the use of water and petroleum, consisting in the following operations: Purifying the graphite mineral from its heavy admixtures (as for instance quartz, iron and the like) by a washing with cold water; mixing said purified graphite mineral with about three or four times its weight of cold water; very strongly agitating said paste within a closed vessel after the addition of a quantity of petroleum of about half the weight of the pure graphite contained in the mixture; and then sprinkling water over the surface of the liquid, after the mixture has been allowed to stand, in order to obtain a quicker and more complete separation of the graphite particles from the earthy substances. Probably both bulk oil and froth flotation involved.

737,593. August 25, 1903. Edmund L. Van der Naillen, San Francisco, Calif. (Apparatus for Extracting Gold and Other Metals from Ores.)

An apparatus comprising a concentrating tank provided with an inlet and an outlet and a valve disposed transversely within the tank and operating when closed to separate the lower portion of the tank from the upper portion thereof.

744,322. November 17, 1903. Arthur De Wint Foote, Grass Valley, Calif. (Process of Preparing Concentrating-surfaces.)

The process of preparing a concentrating-surface, consisting in commingling petroleum and lime and spreading the same evenly over the surface of a concentrator. The metallic minerals stick in the insoluble lime soap and are cleaned off periodically.

745,960. December 1, 1903. Israel F. Good, Allentown, Pa. (Apparatus for Separating Graphite or other Materials from Associated Impurities). Assignor of one-half to George Francis Pettinos, Bethlehem, Pa., and John Herbert Harris, Allentown, Pa.

An apparatus comprising a rotary receiving-table, and pneumatic means for feeding the finer particles of graphite thereon where they float while the coarser portions escape, by sinking, but are later received by adding oil for bulk oil flotation.

758,464. April 26, 1904. Homer L. Orr, Greeley, Colorado. (Mineral Separator.)

In a mineral-separator the combination of a receiving-tank, a separating-tank, a filtering-tank, a pipe or vessel connecting the filtering-tank and the receiving tank having therein a shaft provided with spiral

blades, and means located in the receiving-tank and driven by the inflowing water for operating said shaft to return the filtered liquid oil to the receiving tank to the separating-tank, where oiled minerals, such as flour gold, are buoyed up by an excess of oil and floated off.

762,774. June 14, 1904. James W. Van Meter and Martin P. Ross, San Francisco, California. (Apparatus for the Concentration of Minerals by Means of Oil.)

An apparatus for concentrating minerals by means of oil, comprising a channel through which the oil flows, means for supplying pulp and water to the oil at the head of said channels, means in said channel at intervals for drawing off the settled gangue and water, means at the foot of said channel for separating the relatively upper and lower portions of the oil, and means for returning said separated upper portion of oil to head of the channel.

762,870. June 21, 1904. H. A. Allen, Chicago, Ill. (Apparatus for Separating Materials of Different Specific Gravities.)

An apparatus for separating materials of different specific gravities by the principle of the vortex whirl, in conjunction with a gaseous fluid and a liquid operating through a closed system, said gaseous fluid and liquid aiding to produce a separating action upon the mass to be treated. When the particles of different specific gravities are whirled around inside a suitably designed tank through which a liquid containing bubbles of gas is continuously pumped, the particles tend to separate into horizontal layers and may be drawn off through discharge openings placed at varying heights along the tank.

763,259 and 763,260. June 21, 1904. Arthur E. Cattermole, Highgate, London, England. (Separation of the Metallic Constituents of Ores from Gangue.)

A process of separating metalliferous matter from gangue, which consists in agitating a mixture of powdered ore and water with oil such as oleic acid, in emulsion in water containing an alkaline emulsifying agent, so as to agglomerate the oil-coated particles into granules, and subjecting the mixture to clasification to remove the small non-coated particles from the heavy granules of sulphides. Not a flotation patent, but said by the Minerals Separation Company to have later resulted in froth flotation by reducing the amount of oil.

763,662. June 28, 1904. Guillaume D. Delprat, Broken Hill, New South Wales, Australia. (Apparatus for Use in Certain Processes of Extracting Sulphides from Ores.)

Assignor to Broken Hill Proprietary Company, Ltd., Melbourne, Victoria, Australia. In an ore concentrating apparatus in which the concentrates are floated to the top of a body of liquid, a pan having an inclined perforate bottom down which the ore slides, means to feed liquid to the pan, a sump at the lower edge of the bottom for tailings, a discharge for concentrates at the liquid level of the pan, a baffle-

plate between the sump and pan extending from the discharge to near the lower edge of the inclined bottom to maintain a quiescent body of liquid in the sump and at the same time maintain a flow of liquid from the pan through the discharge. This apparatus is to be used for Delprat's Process patent, 736,071.

763,749. June 28, 1904. George A. Goyder and Edward Laughton, Adelaide, South Australia, Australia. (Process of Effecting the Separating of Minerals.)

In a method of separating minerals and extracting some of them as concentrates, the steps of moving the ore in a finely-divided state in a four per cent solution of sulphuric acid, which by the production of gas causes certain of the minerals contained in said ore to rise; and deflecting and guiding them as they rise. A temperature of 200 deg. F. is often preferable.

763,859. June 28, 1904. James D. Darling, Philadelphia, Pa.

A process of separating carbon from pulverized carbonaceous material, like graphite, which consists of mixing oil with said material; and flowing water through the mixture and through an obstruction or screen impervious to the commingled oil and carbon, but pervious to the water and gangue.

766,289. August 2, 1904. Alfred Schwarz, New York, N. Y. (Process of Separation.)

Assignor to Charles N. Lindley, individually and as trustee, New York, N. Y. A process of separating different materials by the selective action of two or more immiscible liquids of different specific gravities, which consists in introducing the materials in a granular or pulverulent condition, quietly, without downward impetus, and without agitation, into a bath of oil floating upon water. Bulk oil flotation.

768,035. August 23, 1904. Guillaume D. Delprat, Broken Hill, New South Wales, Australia. (Extracting Zinc or Other Sulphides from Their Ores.)

A method of separating ores from their gangue, which consists in forming a hot aqueous solution of an acid capable of reacting with the ore to form a gas and increasing the density of said solution by adding thereto a suitable substance, such as salt cake solution (acid sodium sulphate) of density 1.4, then feeding the mixture of ore and gangue to the solution, decreasing the density of the gas as it is formed on the ore particles, and removing the ore particles raised to the surface. Bubbles of carbon dioxide and hydrogen sulphide form, and the great density of the solution reduces the effective weight of the floated particles.

770,659. September 20, 1904. Joseph B. Scammell, London, England. (Separation of Metals from Their Ores.)

The process consists in bringing finely-ground ore suspended in water into contact with chloride of sulphur diluted from 200 to 400 times with oil matter, whereby the metallic particles combine with the sulpho-chlorinated oil. Bulk oil flotation is obtained, but such a sulpho-chlorinated oil possesses great cohesion and viscosity, making it more effective. Oxidized surfaces on the sulphides are said not to hinder flotation by this oil.

771,075. September 27, 1904. Cosmo Kendall, Upper Norwood, England. (Separation of Mineral Substances by Means of the Selective Action of Oil.)

A process for the treatment of finely-divided material for the separation of graphitic substance contained therein from associated rocky matter or gangue, consisting in mixing said material with water, bringing said material intimately into contact or thoroughly mixing it with suitable pure thin oil, as kerosene oil or paraffin oil, projecting at a considerable velocity the mixture so produced under the surface of a volume composed of said material, water and oil, allowing oil and graphitic substance adhering thereto to pass upward to said surface, and drawing off from said surface oil and graphitic substance immediately on arrival at said surface.

771,277. October 4, 1904. Alice H. Schwarz, New York, N. Y., assignor to Schwarz Ore Treating Company. (Process of Concentrating Ores.)

A method of concentrating ores, which consists in mixing a melted fatty matter which is solid at normal temperature with the ore, then solidifying the fatty matter by introducing cold water and separating the gangue pulp from the values entrained in the fatty matter while the latter is solidified.

771,874. October 11, 1904. W. R. Grant, Denver, Colo. Assignor to Colorado Iron Works Co., Denver, Colorado.

A pneumatic hydraulic separator, fitted with an overflow launder at the top, and consisting of a cylindrical shell having a cone shaped extension riveted to its lower end. At the apex of the cone is a cast iron tip provided with two outlet openings. Compressed air is admitted at the lower part of the cylindrical shell through a pipe header. The fine ascending streams of air carry the lighter particles into the discharge launder, the heavier particles discharging through the bottom openings.

776,145. November 29, 1904. Charles V. Potter, Balaclava, Victoria, Australia. (Process of Separating Metals from Sulphide Ores.)

A process of separating metals from pulverized sulphide ores which consists in adding to the same an acid solution, such as a one

to ten per cent solution of sulphuric acid, which is a non-solvent of the precious metals, then applying heat to the same, and removing the froth or scum of sulphides from the surface of the solution.

777,159. December 13, 1904. Virginia Tunbridge, Newark, New Jersey. Administratrix of John Tunbridge, Deceased. (Apparatus for Recovering Precious Metals.)

An apparatus for recovering slime gold or silver in which soap is added to the pulp which then drops through a layer of oil into a compartment filled with excelsior, on which the oiled metals are caught.

777,273. December 13, 1904. Arthur E. Cattermole, London, England. (Separation of the Metallic Constituents of Ores from Gangue.)

A process of separating metalliferous matter from gangue, which consists in mixing the pulp with an amount of any animal, vegetable or mineral oil or tar product, equaling only a fraction, say four to six per cent, of the metalliferous constituents, agitating the mass until the oil-coated metalliferous matter is agglomerated into granules, and subjecting the mixture to classification to remove the small non-coated particles from the heavy granules of sulphides. A small amount of soap to emulsify the oil is advisable. After thorough mixing, a gentle rolling action often assists in rolling up granules. This is the second commercially successful process using oils for concentrating ores.

777,274. December 13, 1904. Arthur E. Cattermole, Henry L. Sulman and Hugh F. Kirkpatrick-Picard, London, England. (Concentration of Minerals from Ores.)

A process of concentrating ores which consists in mixing the ore pulp with soap solution and a mineral acid so as to liberate from the soap the organic acid which coats the desired mineral particles, but not the gangue, agitating the mixture so as to agglomerate the coated mineral particles into granules and separating the granules from the non-coated gangue. Commonly known as the "Soap and Granulation patent."

778,747. December 27, 1904. James H. Gillies, Melbourne, Victoria, Australia. (Apparatus for Separating Sulphides from Their Ores.)

An apparatus for separating sulphides from ores by the hot acid gas bubble processes, comprising a treatment pan or vessel, means for heating the same, means for conveying a supply of cool or cold acid liquid to the bottom of said pan, and means for permitting said liquid to escape from the bottom of the pan to carry away the drossy matter without lowering the temperature or the level of the heated liquid in the upper part of said treatment pan or vessel.

780,281. January 17, 1905. James H. Gillies, Melbourne, Victoria, Australia. (Apparatus for Recovering Zinc or Other Sulphides from Their Ores.)

In an apparatus for recovering zinc and other sulphides from their ores by the wet or acid chemical flotation process, and in combination, a receptacle a series of radial over-lapping inclined V-shaped catchment-chutes so placed as to guide the rising metallic gaseously-supported particles and on their falling receive and automatically discharge the same, said catchment-chutes being so arranged that each slightly overlaps its neighbor on one side, a central escapement channel into which said particles fall, and means for removing said particles from said channel.

784,999. March 14, 1905. George A. Goyder and Edward Laughton, Adelaide, South Australia, Australia. (Apparatus for Separating and Concentrating Minerals.)

Apparatus for separating minerals and extracting some of them as concentrates, by hot acid flotation, consisting of a vessel adapted to contain a solution, the floor of such vessel being partly horizontal and partly inclined and provided with means for heating the solution, a feeding-hopper extending across one end of said vessel adapted to feed ore or minerals in a finely divided state, a series of transverse rod-rakes, and means for moving them at a regulated speed along the bottom of the vessel from the feed to the discharge end, inclined deflectors along and above the bottom of the separating portion of the vessel, trough-receptacles arranged parallel with the said deflectors and at such distance from the bottom of the vessel as to enable the gas-raised particles of mineral to be deflected, guided, deposited and collected therein, sloping extensions of said troughs and angular rakes for discharging the concentrates from the troughs through the sloping extension of the vessel.

787,814. April 18, 1905. Jacob D. Wolf, London, England. (Separation of Metals from Their Ores.)

A process of separating metals from their ores which consists in agitating pulps with a thick viscous oil until the oil has taken up all the metallic-mineral contents with some gangue, separating the mineral-bearing oil from the pulps, removing suspended particles of gangue from the oil by passing it through warm water and separating metallic minerals from the oil. Any oil entrained in the gangue is recovered by blowing air or steam through it, the oil collecting in a film on the surface.

788,247. April 25, 1905. Arthur E. Cattermole, Henry L. Sulman and Hugh F. Kirkpatrick-Picard, London, England. (Ore Concentration.)

A process of concentrating ores which consists in mixing a freely flowing ore pulp with a soap solution and a mineral acid so as to liberate the organic-acid from the soap throughout the suspended ore

mass in intimate contact therewith, whereby the organic acid coats the desired mineral particles and not the gangue, and thereafter separating the coated mineral matter from the non-coated gangue. This separation can take place by generation of gas bubbles in the pulp to float the oiled sulphides, or by attachment of oiled sawdust or use of an oiled vanner belt. Whether skin or froth flotation results is not mentioned. The process has come to be known as the "Soap and Flotation" Process.

790,913. May 30, 1905. Homer L. Orr and Fred B. Finley, Fort Collins, Colo. (Mineral Reclaimer and Saver.)

A tank divided into a plurality of compartments of different sizes, a screen arranged in the larger compartment, a trough arranged below the screen, a plurality of compartments, each containing a filtering medium and means for supplying oil and water to the compartments, and means for causing the liquids to traverse a tortuous path therethrough. This apparatus applies bulk oil flotation in saving flour gold.

792,617. June 20, 1905. Benjamin Wm. Rice, Caldwell, Idaho. (Apparatus for Saving Precious Values in Soils.)

An apparatus for saving metallic values from sand, gravel, etc., comprising a shaking-screen, a trough supported by arms secured to said screen, a screen-box, bars supported by said screen and positioned underneath the exit end of said trough, a tank adapted to contain water and oil and positioned underneath said screen box, sprocket-wheels mounted within and upon the upper edge of said tank, a sprocket-chain traveling about said wheels, cross pieces secured at intervals to the links of said chain and projecting laterally from the sides of the chain and adapted to travel adjacent to the bottom of the tank substantially its entire length, and a gate positioned within said tank and underneath which said cross-pieces upon the chain are adapted to travel. The apparatus allows bulk oil flotation of "flour" gold.

793,808. July 4, 1905. Henry Livingstone Sulman and Hugh Fitzalis Kirkpatrick-Picard, London, England. (Ore Concentration.)

A process of concentrating ores which has come to be known as the "Bubbles" process, and which consists in bringing the pulp into intimate contact with "oil" in the form of an atomized spray in a gas and thereafter separating the metalliferous constituents from the gangue, by flotation. One apparatus pictured is almost a reproduction of the now well known Callow flotation machine, except that a rotating perforated coil of pipe is used on the bottom instead of a canvas bottom. The Minerals Separation Co., however, denies that this is a frothing process, although they own it.

795,823. August 1, 1905. James D. Darling, Philadelphia, Pa. (Means for Effecting Aqueous Separation.)

An apparatus for effecting aqueous separation which consists of a receptacle; a water inlet and outlet to the same with means for regulating the flow of both; a foraminate partition interposed within the receptacle on the said apparatus toward which the water flows; an agitating apparatus within the receptacle on the side of the partition toward which the water enters; and propeller-blades in proximity to the partition by the rotation of which the material in the receptacle may be constantly driven away from the partition in opposition to the flow of the current. This apparatus is claimed to be adapted to the bulk oil flotation of graphite from its ores.

805,382. November 21, 1905. Walter Murray Sanders, Iola, Kansas. (Process for Concentrating Ores.)

The method of concentrating ore, which consists in subjecting it to a non-acid solution, such as a solution of aluminum sulphate of 1.2 sp. gr., capable of reacting with the ore or sulphide minerals, with evolution of gas, such as hydrogen sulphide, and collecting such particles as are sustained by the evolved gas. The solution is preferably heated.

807,501. December 19, 1905. Alfred Schwarz, New York, N. Y. (Process of Concentrating Ores.) Assignor to Schwarz Ore Treating Company, Phœnix, Arizona Territory, a corporation of Arizona Territory.

The method of treating ores which consists in subjecting an oxidized ore to the action of a soluble sulfide such as sodium sulfide, to convert the mineral into a sulfide, then treating the mass with a hydro-carbon and finally separating by screening or by flotation, the hydro-carbon with the entrapped metallic constituents of the ore from the tailing. An excess of sulphur above the theoretical quantity necessary to sulphidize the oxidized mineral is used, although only a sulfide film is formed.

807,502. December 19, 1905. Alfred Schwarz, New York, N. Y. (Process of Concentrating Ores.) Assignor to the Schwarz Ore Treating Company, Phoenix, Arizona Territory, a corporation of Arizona Territory.

The method of concentrating ore which consists in mixing with the pulverized ore an agent to which the metallic constituents will adehere, consisting of a mixture of a normally non-liquid resinous hydro-carbon and a non-resinous hydro-carbon, then separating said adhesive agent with the entrapped values from the tailings, and finally separating the values from said agent. Air may be injected to increase the sponginess of the masses of oil and entrapped sulphides.

807,503. December 19, 1905. Alfred Schwarz, New York, N. Y. (Process of Concentrating Ores.) Assignor to the Schwarz Ore Treating Company, Phoenix, Arizona Territory, a corporation of Arizona Territory.

The process of concentrating ores consisting of mixing with the pulverized ore a selective agent consisting of a mixture of a liquid hydrocarbon and a normally solid fatty matter, which mixture is solid at a normal temperature, separating said agent with its entrapped values from the tailings, and finally recovering the values from the selective agent.

807,504. December 19, 1905. Alfred Schwarz, New York, N. Y. (Process of Concentrating Ores.) Assignor to Schwarz Ore Treating Company, Phoenix, Arizona Territory, a corporation of Arizona Territory.

The process of concentrating ore consisting in melting a normally solid hydrocarbon mixing any pulverized ore therewith, separating said hydrocarbon with its entrapped values from the tailings by subjecting the mixture to the action of a bath of heated water while maintaining said hydrocarbon in a melted condition, and finally recovering the values from the hydrocarbon.

807,505. December 19, 1905. Alfred Schwarz of New York, N. Y. (Process of Concentrating Ores.) Assignor to Schwarz Ore Treating Company of Phoenix, Arizona Territory, a corporation of Arizona Territory.

The process of concentrating ores consisting in mixing the ore out of contact with water with an adhesive agent composed of a hydrocarbon and sulphur, separating said agent with the entrapped values from the tailings, and recovering the values from the adhesive agent.

807,506. December 19, 1905. Alfred Schwarz of New York, N. Y. (Process of Concentrating Ores.) Assignor to Schwarz Ore Treating Company of Phoenix, Arizona Territory, a corporation of Arizona Territory.

The process of concentrating ores consisting in melting a normally solid resinous hydrocarbon, mixing the pulverized ore therewith and separating said hydrocarbon with its entrapped values from the tailings, and finally recovering the values from the resinous hydrocarbon.

809,959. January 16, 1906. Edmund B. Kirby of Rossland, Canada, (Process of Separating Minerals.)

The process of separating minerals, which consists in thoroughly mixing together the pulverized mineral material, a considerable quantity of water, and a solution of bitumen and kerosene, amounting to 25-75 per cent of the weight of the ore; in gently agitating this mixture, and in blowing a gas into the same to assist in the flotation of the oil and the mineral particles which have been coated thereby; and in separating said oil and mineral particles.

816,303. March 27, 1906. John Henry Davis of Glens Falls, New York. (Graphite-Separator.)

A graphite-separator, comprising a main trough, means for feeding graphite ore and water thereto, means for maintaining a water-level in the trough, and a series of partitions in the trough, each provided with a separating-plate having its front end located just below said water-level; each of said plates being provided with means for carrying away fine sand and mud from a point near the surface of the water. Possibly film flotation is involved in this patent.

822,515. June 5, 1906. Fred B. Finley of Los Angeles, California. (Ore-Separator.)

In an ore-separator, the combination of a tank provided with an outlet-valve, a combined hopper and coil mixer arranged within the tank, a second tank into which the first tank discharges, a third tank into which the second tank discharges, a float-operated valve in the second tank for controlling passage of oil to the third tank, a valve in the first tank, a rock-beam, and a connection between the rock-beam and the float of the second tank and the valve of the first tank. Bulk oil flotation of metallic gold occurs.

825,080. July 3, 1906. Alfred Schwarz of New York, N. Y. (Separator for Use in the Concentration of Ores.) Assignor to Schwarz Ore Treating Company of Phoenix, Arizona Territory, a corporation of Arizona Territory.

In a separator for use in the concentration of ores, by Schwarz earlier patents, the combination of a kettle adapted to contain water, shelves supported within said kettle, scrapers co-operating with said shelves to impart a continuous movement to the contents of the kettle, an over-flow discharge outlet at the top for the concentrates and adhesive agent, and a discharge-outlet at the bottom of the kettle for the tailing.

825,909. July 17, 1906. Edmund B. Kirby of Rossland, B. C., Canada. (A method of recovering the oil from the bulk oil froth concentrates of former patents, consisting in distilling it off with the aid of superheated steam.)

A process for distilling off the oil from the concentrate obtained by an oil process of concentration. The oil coated particles are fed from a hopper into the inclined shaft of a report furnace, the temperature of which is maintained at the distillation point of the oil used. The particles move slowly down the inclined shaft and are caught in suitable bins at the bottom.

826,411. July 17, 1906. Francis Edward Elmore of London, England. (Process for Separating Finely-Divided Material.)

A process of separating certain constituents of finely-divided material consisting in mixing the material with a liquid and a substance that has a selective affinity for some of the constituents, sub-

jecting the mixture to a pressure below that of the atmostphere, in order to form a froth by the bubbles of dissolved gases released by the vacuum, and collecting the particles floated. Elmore claims that this method requires much less oil or acid than former processes. This method of froth flotation is often called the "vacuum" method.

835,120. November 6, 1906. Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot of London, England. (Ore Concentration.)

The process of concentrating powdered ores which consists in separating the mineral from the gangue by coating the mineral with an oil, such as oleic acid, in water containing a small quantity of oil, less than one per cent, warming the mixture, agitating the mixture to form a permanent froth, and separating the froth. In the suit of Mineral Separation vs. Miami Copper Co., the former, who own this patent, claim that a new effect is obtained by using such a small amount of oil and that an "air froth" different from former "oil froths," is obtained. This patent is claimed as their basic patent. In the suit of Minerals Separation vs. Hyde, which was decided in favor of Hyde, this patent was adjudged as showing nothing new, merely economy of oil.

835,143. November 6, 1906. Henry Livingstone Sulman of London, England. (Ore Concentration.)

A process for concentrating ores which consists in mixing the powdered ore with water, adding a small proportion of oily liquid having a preferential affinity for metalliferous matter, agitating the mixture, heating the mixture until gaseous bubbles are generated therein so that the oil-coated mineral matter forms into a froth and separating the froth from the remainder by flotation. Known as the "boiling" patent, from the manner of generating the bubbles of gas which form the froth. Even steam bubbles are involved.

835,479. November 6, 1906. Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot of London, England. (Ore Concentration.) Assignors to Minerals Separation, Limited, of London, England.

The process of separating powdered minerals from one another, which consists in suspending the powdered minerals in a liquid, subjecting the mixture to a gas pressure to dissolve an excess of gas in the water, and thereafter relieving the pressure whereby bubbles of gas are liberated in the pulp and carry certain minerals to the surface. This might be called the "pressure" patent.

838,626. December 18, 1906. Edmund B. Kirby of Rossland, British Columbia, Canada. (Separating-Tank.)

The combination of a separating-tank containing agitator mechanism, with means for discharging into the contained fluid charge a gas and a liquid lighter than water and immiscible therewith. Probably both bulk oil and froth flotation involved.

842,255. January 29, 1907. Alfred Schwarz of New York, N. Y. (Process of Concentrating Ores.) Assignor to Schwarz Ore Treating Co., of Phoenix, Arizona Territory, a corporation of Arizona Territory.

The method of concentrating ores consisting in mixing with the pulverized ore resin-oil, then separating said agent with its entrapped values from the tailings and finally recovering the values from said agent.

851,599. April 23, 1907. James Francis Latimer of Toronto, Ontoria, Canada. (Apparatus for Separating Minerals.)

An apparatus comprising a vessel provided with a funnel-shaped bottom having a controlled discharge-opening at the apex thereof; an upwardly-sloping deflecting plate extending into said vessel; a screen of suitable mesh supported with said vessel at the top of the funnel-shaped bottom thereof—a rotatable pipe or conduit for introducing water into said vessel and having its discharge-end opening below said screen; horizontally-held paddles supported by said conduit at the required angle and designed to operate above said screen so as to create a centrifugal force so as to divide the graphite from the rocky matter or gangue and at the same time create an additional upward current in the water above said screen to that caused by the flow of water upward through said screen so as to cause the oil-provided graphite to rise to the top of the water so that it may be caught by said deflecting plate and so conducted out of said vessel.

851,600. April 23, 1907. James Francis Latimer of Toronto, Ontario, Canada. (Process for Separating Minerals.)

The process of separating graphite and similar substances from rocky matter and gangue, consisting in mingling the crushed ore with oil; delivering the oil-provided mass to; and maintaining it in an up-flowing current of water; centrifugally agitating the mass to separate the components and so accelerate the current as to carry the oil-provided graphite to the top of the water; flowing the so separated graphite away; settling the gangue through an upflowing current of reduced speed below the zone in which the material is fed and agitated, and removing said gangue by a downwardly-flowing current.

864,597. August 27, 1907. Auguste Joseph Francois Debavay of Kew, Victoria, Australia. (Process of Separating Zinc-Blende by Flotation.)

A process of separating zinc blende particles from ores, tailing and concentrates in a pulverized condition comprising the freeing of zinc blende particles from the carbonates and other impurities by first submitting the material to the action of a chemical re-agent, and then discharging the material in a film-like manner into a body of water by delivering the material in a thin pasty condition in the presence of a stream of water upon an inclined surface extending to said body of water, and then separating the film of zinc blende float-

ing on the water from the remaining ores, tailings or concentrates which precipitate in the body of water.

864,856. September 3, 1907. Dudley H. Norris of New York, N. Y. (Method of Separating the Metallic and Rocky Constituents of Ores.)

The method of separating the metallic and rocky particles of ore, which consists in introducing a stream of water containing air in solution into a mixture composed of crushed ore, oil and water to cause bubbles of air to form in said mixture and rise to the surface thereof to carry off the metallic particles of the ore. Air obtained in solution by pressure. Norris claims that oil can be omitted as the air bubbles do the selecting.

865,194. September 3, 1907. Arthur P. Stanley Macquiston of Glasgow, Scotland. (Process for Separating Solids.)

A process for separating solids having different surface affinities for liquids, consisting in forming a pulp of the mixture, bringing the commingled particles through the surface of a gently flowing stream of liquid and returning the same to the stream in a direction transverse to the flow of the stream, and collecting concentrates thereby caused to float upon the stream in a film, one particle deep.

865,195. September 3, 1907. Arthur P. Stanley Macquisten of Glasgow, Scotland. (Apparatus for Separating Solid Particles from Each Other.)

Means for separating a mixture of finely divided particles of ore, by the process of No. 865,194, comprising a cylinder arranged to rotate in contact with a body of liquid, said cylinder passing through the surface of the liquid in such direction as to carry the particles there through and to cause them to roll back to the surface of the liquid, said cylinder having a ribbed interior surface.

865,260. September 3, 1907. Arthur Penrhyn Stanley Macquisten of Glasgow, Scotland. (Apparatus for Separating Solid Particles from Each Other.)

Means for separating a mixture of finely-divided particles of ore, comprising a support for said particles arranged to move in contact with a body of liquid, said support passing through the surface of the liquid in such direction as to carry the particles there through and to cause them to roll back to the surface of the liquid.

865,334. September 3, 1907. Alexander E. Elmore, London, England. (Apparatus for Concentrating Ores.) Assignor to the Ore Separation Company (1905) Limited, London, England.

Apparatus for the treatment of ores with oil, comprising a mixing tank, a mixing device for intimately mixing a pulp of the ore with oil in the mixing tank, and a floating sea of oil inclosed by a ring for excluding the air from the said tank during the mixing process. Bulk oil flotation.

873,586. December 10, 1907. Dudley Hiram Norris of New York, N. Y. (Apparatus for Separating the Metallic Particles of Ores from the Rocky Constituents Thereof.)

An apparatus for carrying out patent No. 864,856, comprising a receptacle having its upper end open to the atmosphere and adapted to receive a flowing mixture of pulverized ore and water, means for introducing a stream of water containing air in solution into the mixture in said receptacle to cause infinitesimally small nascent bubbles of air to form in said mixture and rise to the surface thereof to collect the metallic particles of the ore together, a member arranged at the upper end of said receptacle to receive the metallic particles of the ore, and a discharge pipe at the lower end of the receptacle out of which the water and the rocky particles of the ore pass.

879,985. February 25, 1908. Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot of London, England. (Separation of Metalliferous Minerals from Gangue.)

The process of treating ores to separate metalliferous matter from gangue which consists in mixing the powdered mineral with water to form a freely flowing pulp, agitating the mineral pulp with a small quantity of oil, fatty or tarry substance, sufficient only to impart a thin coating of oil to the metalliferous particles, distributing the mixture in the form of a thin sheet of flowing liquid, causing the immersed particles to be exposed to the air and thereafter to meet the surface of the liquid, collecting the floating oiled metalliferous particles and collecting the gangue which sinks. This amounts to film flotation of oiled particles. Does not claim raising of oiled particles to the surface by the aid of gas bubbles.

889,300. June 2, 1908. B. E. Duggan, Telluride, Colo. (Slime Saving Device.)

A device for skimming the floating minerals from the surface of a concentrating table, comprising two converging deflecting arms arranged in the form of a Y, which conduct the floating minerals to a spout, which, in turn, discharges them into a suitable settling tank or box.

899,149. September 22, 1908. Jacob D. Wolf of London, England. (Separation of Metals from Their Ores.)

The combination with a traveling belt, of means for coating one face of same with a metal selective substance, means for roughening said coating, said roughened coating adapted to receive wet ore pulp, and means for relieving said belt of said selective substance and adhering metals. Not flotation but the selective adherance of oil to sulphides is utilized.

899,478. September 22, 1908. Jacob David Wolf of London, England. (Process for Separating Metals from Their Ores.)

A method of separating metals from their ores which consists in forming a pulp; passing said pulp containing the metals over an

oily adhesive substance; and in abrading the surface of said substance by drawing apart the body of the same, and thereby causing some of the mineral particles to adhere thereto.

902,018. October 27, 1908. Henry Livingstone Sulman and Evan Aspray Sulman of London, England. (Ore-Concentrator.) Assignors to Minerals Seperation, Limited, of London, England.

In an apparatus, resembling a buddle or round table for concentrating ores, the combination of a fixed surface, means for feeding powdered ore over the surface, means for continuously feeding a thin stream of liquid over the surface, a movable body having a flexible squeegee edge in contact with the surface sufficiently flexible to pass over the ore while exerting sufficient pressure on the surface to remove the film of water therefrom, means for sweeping the body over the surface in a direction at right angles to the direction of flow of the water to cause the ore to be alternately exposed to the air and to the edge of the liquid. Film flotation.

911,077. February 2, 1909. Walter Murray Sanders of Marion, Kentucky. (Apparatus for Concentrating Ores.)

Apparatus for applying patent 805,382, for concentrating ore by flotation, comprising a tank having means for introducing ore and solution below the normal liquid surface, a central discharge gate for tailings, a substantially central overflow for concentrate, and means for imparting a whirling motion to the liquid in the tank.

912,783. February 16, 1909. Auguste Joseph Francois De Bavay of Kew, Victoria, Australia. (Apparatus for Separating Ores by Flotation.)

An apparatus for applying De Bavay's process, patent No. 864,597, with the combination of a feed pipe, a rotary worm therein, an ore supply connected to each terminal of said pipe, a water supply pipe arranged parallel and adjacent to said feed pipe, a plurality of inclined chutes, distributing means extending transversely of each chute, a liquid containing receptacle at the lower end of each chute, provided at one side with an adjustable overflow lip and inclined gutter for receiving and conveying the particles capable of flotation, an endless traveling belt in each of said receptacles having one end submerged therein and adapted to convey the heavier constituents from one trough to the succeeding inclined chute, spray pipes adapted to deliver water upon the belts after they have emerged from said receptacles, and operating means common to said distributing means and said endless traveling belts.

933,491. September 7, 1909. Marcus Ruthenburg of Lockport, New York. (Ore Separating Process.)

A process of separating ore or concentrate particles of different specific gravity, which cannot be wetted in water, which consists in surrounding the same with a non-metallic liquid capable of wetting

the surfaces of said particles so that they are separated by gravity processes in said liquid. Slimes and finely divided mixtures of sulphides can thus be tabled in a pulp made up of oil and ore; no flotation involved.

933,717. September 7, 1909. Alfred A. Lockwood and Marcus R. A. Samuel, London, England. (Process of Treating Ores.)

The process of treating ores, which consists in mixing an ore with a magnetic substance and an oily liquid adapted to cause the magnetic substance to adhere to some constituent part of the ore in preference to the others, and then magentically separating the mixture. This process is known as the Murex Process.

937,325. October 19, 1909. H. L. Orr, Georgetown, Wash. (Ore Separator and Concentrator.)

An improved ore concentrator comprising a primary tank in which an inclined moving belt, mounted on suitable pulleys, passes from a lower corner up and over the opposite end and discharges into a smaller tank. The framework on which the belt operates reciprocates in the direction of the line of travel of the belt. An amalgamating plate is inclined downward toward the belt and extends upward to a point several inches below the surface of the water in the tank. Ore is fed into the tank directly above the plate and passes down through the water onto the plate which catches the amalgamable gold and directs the ore onto the moving belt, which carries the adhering mineral to the discharge tank. Any greasy or floating mineral, remaining on the surface of the water, is directed by jets of air from a suitably arranged pipe to one corner of the primary tank, and escapes through an intermittently operated gate into a third tank. Here a paddle wheel raker pushes the float to the other end of the tank, where it remains until the valuable ingredients coagulate and settle to the bottom.

938,732. November 2, 1909. Henry Azor Wentworth of Newton, Massachusetts., (Roasting Separation Process.) Assignor to Huff Electrostatic Separator Company of Boston, Massachusetts, a corporation of Maine.

The process of separating zinc sulphide from other sulphides associated therewith which consists in superficially changing sulphides other than zinc sulphides by subjecting the mass to heat, and thereafter separating by flotation, the heat-affected particles from those unaffected.

942,663. December 7, 1909. S. Rachelman, St. Paul, Minn. (Apparatus.) Assignor to Northern Placer Machine Co., St. Paul, Minn.

An apparatus for washing out and retaining placer gold, comprising a revolving pan provided with magnetic plates for catching the magnetic sands and an upper lining of loose fuzzy material, heavily coated with beeswax or equivalent material, whose function it is to catch and hold the particles of fine gold.

949,002. February 15, 1910. A. S. Ramage, Newark, N. J. (Assignor to Chemical Development Co., Buffalo, N. Y.)

A process for separating the valuable minerals from such ores as chalcopyrite, bornite, or erubescite, and mixtures of the same with pyrites, zinc blende, or ores containing cobalt and other sulpharsendies by a combination of fractional roasting followed by chemical floating, e. g. an ore of chalcopyrite and pyrite is first roasted to decompose the iron sulphide, leaving the copper sulphide unchanged. It is then floated in a hot solution of acid sulphate of soda and free nitric acid, when the chalcopyrite rises to the top of the bath and can be skimmed off.

952,222. March 15, 1910. R. S. Towne, New York, N. Y. (Apparatus.)

An apparatus for agitating liquid material in which agitation can be carried on during the operation of filling and emptying the tank, comprising a tank with either an interior or exterior pipe or column opening at top and bottom into said tank, and provided at the bottom with an air jet. A number of pipes or openings, at various heights along the column, provide for the continuous circulation of the liquid from the column to the tank irrespective of the depth of the liquid in the tank.

953,746. April 5, 1910. Theodore Jesse Hoover of London, England. (Apparatus for Ore Concentration.) Assignor to Minerals Separation Limited of London, England.

In an apparatus for concentrating ores by gaseous flotation of certain mineral particles in liquid, the combination of, an agitation vessel, a spitzkasten contiguous thereto, said vessel and spitzkasten adapted to contain circuit liquid, means for agitating the contents of the agitation vessel so as to beat air into the liquid, and a wall between the agitation vessel and the spitzkasten having a wide communication orifice below the level of the liquid in both vessels, said agitation vessel adapted to discharge substantially directly into the spitzkasten. This is an early form of the present standard Minerals Separation machine.

955,012. April 12, 1910. Henry Livingstone Sulman of London, England. Assignor to Minerals Separation, Limited, of London, England. (Concentration of Ores.)

A process of concentrating ores which consists in mixing the powdered ore with slightly acidified water containing in solution a minute quantity of an alcohol, such as .002 to .01 per cent amyl alcohol, agitating the mixture, bringing the ore particles into contact with air so as to cause the metallic sulfides to float in a coherent froth and separating the floating particles.

956,381. April 26, 1910. Alfred A. Lockwood and Marcus R. A. Samuel, London, England. (Process of Treating Ores.) Assignors to the Murex Syndicate, Limited, London, England.

A process of treating sulfid ores which consists in crushing ores composed of friable sulfids in which the commingled grains or particles are bound together by a sulfide, agitating such crushed ores with an alkaline silicate solution to weaken the bonds between the grains of the commingled sulfides on cleavage lines so that they may be advantageously separated without excessive grinding and concomitant sliming and then subjecting said particles to separation and separate collection. Not a flotation process.

956,773. May 3, 1910. Alfred A. Lockwood of London, England. (Process of Treating Ores and Carboniferous Earths.)

In a process for treating ores, agitating the ore with a mixture comprising water, an insoluble metallic compound containing oxygen and an oily liquid which has been so treated that it contains a minute quantity of metallic compound insoluble in water, such as an aluminum soap, for the purpose of preventing the washing out of said insoluble metallic compound, and then separating the oiled particles from the unoiled particles by a flotation process.

956,800. May 3, 1910. James Dunstone, of Dollar Bay, Mich. (Process for Treating Metallic Slimes.)

The process consisting in agitating metallic copper slimes in the presence of an emulsion of oil, an aqueous solution of sodium nitrate, and an acid adapted to decompose the sodium nitrate, and collecting the portion floated.

962,678. June 28, 1910. Henry Livingstone Sulman, Henry Howard Greenway and Arthur Howard Higgins of London, England. (Ore Concentration.)

A process of concentrating ores which consists in mixing the powdered ore with acid water containing in solution a small quantity of a mineral-frothing agent, such as phenol, cresol, amyl acetate, etc., agitating the mixture to form a froth and separating the froth. This is the first mention of soluble frothing agents, although some of the tars previously mentioned contain soluble constituents. This patent belongs to the Minerals Separation Company.

967,671. August 16, 1910. Alexander S. Ramage of Detroit, Michigan. (Method of Separating Minerals.) Assignor to Chemical Development Co., of Buffalo, N. Y., a corporation of Colorado.

The method of treating ores containing a plurality of mineral components, which consists in immersing the ore in a suitable solution, separately floating said mineral components by progressively raising the temperature of the solution, and removing at each rise of temperature the product separated during such rise. This is one of the first patents claiming a true differential flotation.

968,206. August 23, 1910. L. Strom, Los Angeles, California. (Art of separating liquids and apparatus therefor.)

An apparatus for separating oil from water by a mechanical device making use of centrifugal force.

970,002. September 13, 1910. Henry Azor Wentworth of Lynn, Massachusetts. (Process of Separation.) Assignor to Huff Electrostatic Separator Company of Boston, Massachusetts, a corporation of Maine.

A differential flotation process which consists in associating with the material a substance chemically reactive upon particles thereof, thereby producing upon the particles affected by the reactive substance superficial coatings of a compound different from the original substance of the particles in respect to film-tension of a liquid, and thereupon separating the differentiated particles by film-tension of said liquid.

972,459. October 11, 1910. F. S. MacGregor, Hyde Park, Mass. (Apparatus.) Assignor to Huff Electrostatic Separator Co., Boston, Mass.

An apparatus for separating the various minerals from ores which have been treated by the process invented by Wentworth (U. S. patent 938,732. q. v.) comprising a tank divided into several compartments, the partitions between which are progressively lower in height when passing toward the discharge end of said tank, thus causing a flow when the liquid is drawn off from the last compartment and pumped back to the first compartment. Aprons or short flumes, studded with pins, extend nearly the whole length of each compartment, the function of which being to cause a thorough mixing of the particles and liquid before passing into a compartment. In operation the treated ore is gently presented to the surface of the liquid at the head of the tank, and on passing the several compartments, the particles offering various degrees of resistance to being wetted, are progressively wetted, which causes them to sink when they can be drawn off from the bottoms of the various compartments.

973,467. October 25, 1910. Samuel K. Behrend, of Denver, Colo. (Apparatus for Separating Minerals from Their Ores.)

The combination with a separating tank adapted to contain liquid, and a pipe which discharges radially at the center of the tank and at the surface of the liquid therein, of a barrier located between the water inlet and overflow, said barrier having members in the path of the film of material floating thereon, and a screen located above the tank between said means and the water outlet, for sifting the material to be treated upon the surface of the liquid in the tank.

979,820. December 27, 1910. S. K. Behrend, New York, N. Y.

A flotation tank for ore dressing, comprising a number of inverted pyramidal shaped cells connected in series, the partitions between the cells being capped with wide flat plates placed just slightly

below the surface of the water flowing through the tank. In operation the finely divided ore is fed onto the surface of the water, and, on passing over the plates, the thin film of water is slightly agitated, causing some of the particles to settle and be deposited in the following cell or compartment. As many cells may be used as the conditions of the ore require.

979,857. December 27, 1910. Theodore Jesse Hoover, London, England. (Apparatus for Ore Concentration.) Assignor to the Minerals Separation, Limited, London, England.

Apparatus for concentrating ores by gaseous flotation of certain mineral particles in liquid comprising in combination a mixing vessel, an agitator in the mixing vessel, a spitzkasten at the outlet of the mixing vessel, a secondary mixing vessel, a centrifugally acting agitator in said secondary mixing vessel and a connecting conduit between the tailings outlet of the spitzkasten and the zone of the suction influence of the centrifugally acting agitator of said secondary mixing vessel. The multiplication of agitating compartments and spitzkastens in series resulted in the modern Minerals Separation flotation machine.

980,035. December 27, 1910. H. A. Wentworth, Newton, Massachusetts. (A Process of Separation.) Assignor to Huff Electrostatic Separator Co., Boston, Massachusetts.

Whereby a mass of mixed ore particles is treated by a chemical re-agent which produces on some of the particles a superficial coating, more susceptible of wetting by, or, having a greater avidity for, a liquid, than the original particle. Thus ore not ordinarily amenable to flotation, can be so treated and a satisfactory separation made. The re-agent employed is a halogen, preferably chlorin. It acts most effectively on particles of pyrite, causing them to be easily wetted.

980,143. December 27, 1910. Z. Cartwright of Ilford, England. (Method of Obtaining Solution of Certain Metallic Oxides.)

A process for separating certain metallic oxides, mainly of iron, by placing them in an aqueous solution having not less than one-half of one per cent of saponaceous material. By increasing this percentage slowly the oxides may be collected together to any desired degree of concentration. They may then be precipitated by the addition of an alkali.

984,633. February 21, 1911. H. E. Wood, Denver, Colo. (Process and Apparatus for Concentrating Ores.)

A process for concentrating metalliferous ores which consists in feeding the dry ore in a finely divided state upon the surface of a body of water, and recovering the valuable minerals which remain supported on the surface film of water. The apparatus comprises an inclined plate over which water is caused to flow in a thin sheet, a device for feeding the dry ore in a uniform stream upon the sheet of water, and a tank arranged for the splitting off of the surface film of water with the particles supported thereon.

987,209. March 21, 1911. H. E. Wood, Denver, Colorado. (An Ore Concentrator.)

An apparatus for concentrating ore by film flotation, comprising and inverted conical tank, provided with an inlet for water so arranged as to give a tangential direction to the inflowing water and causing a gyratory current to be set up on the surface of the water in the tank. An outlet or discharge pipe is provided at the apex of the tank. The floating minerals are collected by a suitably curved screen, dipping into the water, and directing them to a small inner conical tank which, in turn, discharges into a pipe passing out through the side of the main tank.

988,737. April 4, 1911. Walter Murray Sanders, Marion, Kentucky. (Process of Concentrating Ores.)

The process of concentrating sulfid ores, which consists in first concentrating the ore to effect a substantially complete separation of calcite, and thereafter subjecting the purified ore to further concentration by flotation in a solution adapted to react upon the ore to produce bubbles and capable of reacting upon calcite. The advantage claimed is removal of calcite which uses up the acid often used in flotation.

994,950. June 13, 1911. F. I. DuPont, Wilmington, Delaware. (Process.)

A process for the separation of solids from each other by the use of liquids, the separating liquid being insoluble in and more volatile than the other liquid used. In the example given, pure coal is separated from accompanying slate and shale by passing the material into a tank containing carbon tetrachloride. The coal floats and is removed by a conveyor, the slate and shale sink and are removed by a second conveyor. Both products are delivered to tanks containing water, heated by steam pipes. The carbon tetrachloride being insoluble in water and more volatile, is driven off and condensed for further use.

996,491. June 27, 1911. Alfred Arthur Lockwood, London, England. (Magnetic Preparation of Ores.) Assignor to Murex Magnetic Company, Limited, London, England.

In the magnetic preparation of an ore, the process which consists in treating the ore with a finely ground magnetic substance, an oily liquid, and a solution of a sulfid of an alkali metal and magnetically separating the mixture. The magnetic substance and oil coat the sulphides. This is not a flotation patent.

1,002,865. September 12, 1911. F. I. DuPont, Wilmington, Delaware.

A process for the gravity separation of certain iron ores from gangue. Limonite ores are first heated to drive off the contained water. The treated ore is then delivered to a tank containing a solution of antimony bromide at a temperature of 100 degrees C. The

silica and gangue float on the surface, while the purified iron oxide sinks.

1,004,815. October 3, 1911. F. I. DuPont, Wilmington, Delaware.

In processes of separating solids in heavy solutions, the liquid carried away by the solids is recovered by volatilization and condensing. Certain liquids are more or less decomposed by volatilization and leave a residue in the ore. This can be remedied by adding a haloid of ammonia, such as ammonium chloride, to the liquid, which prevents the formation of any residue during volatilization.

1,014,624. January 9, 1912. Francis I. du Pont of Wilmington, Delaware. (Liquid Ore Separation.)

The process of separating solids of different specific gravities, consisting in using a liquid whose specific gravity is intermediate between that of the valuable mineral and that of the gangue, like anhydrous antimony bromid, passing the mixture to be separated there through and separately discharging the portions which float and those which sink.

1,014,977. January 16, 1912. Benjamin Sedgely Smith, of Manly, near Sydney, New South Wales, Australia. (Apparatus for the Wet Dressing of Sulfid Ores.)

An apparatus for concentrating and classifying sulfid ores, the combination of conducting means for a film of water, means for distributing ores on the surface of the film of water, an inclined table provided with an aperture therein, a valve controlled receptacle open to and in water tight engagement with the said aperture in said table, and a drowning box interposed between said conducting means and said table to conduct the ore carrying film of water from the former to the latter, to thoroughly submerge the ore therein whereby it sinks into said receptacle upon reaching the same.

1,020,353. March 12, 1912. Edward James Horwood of Broken Hill, New South Wales, Australia. (Process of Treating and Subsequently Separating Sulfid Ores, etc.)

The process of separating zinc sulfid from other sulfids associated therewith which consists in superficially changing sulfids other than zinc sulfids by subjecting the mass to a slight roast, and thereafter separating by flotation, the heat-affected particles from those unaffected.

1,022,085. April 2, 1912. James M. Hyde, of Basin, Montana. (Art of Concentration of Mineral Substances.)

A continuous process of concentrating the valuable constituents from ore pulps, comprising the addition to the pulp of an acid precipitant adapted to react upon the ore or coagulate the fine slimes, allowing a time interval to elapse prior to subjecting it to the flotation

treatment, then subjecting the pulp to a separation treatment comprising the steps of adding a non-metallic material, such as a flotation oil, which will preferentially coat the valuable particles of the ore and separating said coated particles as a concentrate.

1,032,732. July 16, 1912. William Sullivan Blaine, of Torreon, Mexico. (Apparatus for Separating Particles of Rubber from Materials with which they are Commingled.) Assignor to Intercontinental Rubber Company, of New York, N. Y., a corporation of New Jersey.

Apparatus for separating particles of rubber from materials with which they are commingled, said apparatus comprising a flotation tank, a concentrating table communicating with said tank at one end thereof, and an overflow for floating rubber from the flotation tank, so arranged as to maintain a shallow covering of water upon the concentration table.

1,032,733. July 16, 1912. William Sullivan Blaine, of Torreon, Mexico. (Method of Separating Particles of Rubber from Materials with which they are Commingled.) Assignor to Intercontinental Rubber Company, of New York, N. Y., a corporation of New Jersey.

The method of separating particles of rubber from materials with which they are commingled, which consists in separating the rubber particles by flotation in a body of water, and withdrawing the heavier residues or sinkers into an auxiliary substantially quiescent body of water and under such back pressure as will substantially prevent reentrance into the sinkers, of rubber particles that have been released, and floated.

1,043,850. November 12, 1912. Alfred Arthur Lockwood, of London, England. (Process of Separating Ores.) Assignor to Murex Magnetic Company, Limited, of London, England.

A process which consists in treating the ore with an oily liquid, water and with a silicate of an alkali metal to modify the behavior of the oil toward the constituents in the ore and separating the oiled constituents from the unoiled constituents. This process in which flotation can be used is interesting in showing a method for oiling one sulphide while another remains unoiled.

1,043,851. November 12, 1912. Alfred Arthur Lockwood. (Process of Separating Ores.) Assignor to Murex Magnetic Company, Limited, of London, England.

A process which consists in treating an oxidized ore with an oily liquid and water; aiding the oiling of the oxidized metalliferous contents of the ore by treatment with a carbonate of an alkaline metal and separating the oiled constituents from the unoiled constituents, by either Murex magnetic separation or by flotation.

1,045,970. December 3, 1912. Thomas John Greenway, of Armadale, near Melbourne, Victoria, Australia. (Separation of Metallic Sulfids from Sulfid Ores.) Assignor to Potter's Sulphide Ore Treatment, Limited, of Melbourne, Australia, a corporation of Victoria, Australia.

A process for the improvement of the hot acid flotation separation of metallic sulfids from sulfid ores which consists of first intimately mixing finely divided particles of the ore with a small proportion of viscous oil; secondly, feeding the oiled ore into a heated acidulated solution; thirdly, skimming or floating off the coherent buoyant scum of gasified oiled sulfid particles, and separately withdrawing the unoiled sunken gangue particles. Increased coherence of the scum of floated material is claimed.

1,052,061. February 4, 1913. Robert Henry Jeffrey, of Gabriel, Mexico. (Ore Float-Separator.)

An ore-float separator containing a body of liquid, means giving the effective surface of the liquid conical form, a centrally disposed liquid supply delivering the liquid radially outward in all directions, an ore distributer above the liquid and adjustable to and from the liquid surface, and means for imparting rotary motion to the ore distributor. A film flotation is obtained.

1,055,495. March 11, 1913. Carl Schick, of Siegen, Germany. (Process for Treating Ores.)

A process of treating ore slimes which consists in mixing the slimes with a small fraction of a pound per ton of ore of a chlorin derivative of benzol, agitating the mixture, subjecting the mixture to an acid bath, and permitting the settlement of the mixture. The sulphide float and the gangue sinks.

1,056,952. March 25, 1913. Alexander Herbert Smith, of Glasgow, Scotland. (Apparatus for Separating Minerals.)

A device for preventing water and gangue flowing into the concentrates launder of a flotation machine. The combination of a spitzkasten having an open top, a concentrate lip and a straight side wall having a slot lower than said lip and remote from the bottom of the spitzkasten; a pocket surrounding said slot and provided with a lip higher than said slot and lower than the concentrate lip; and means for conducting mineral feed into the spitzkasten.

1,058,111. April 8, 1913. Alexander H. Smith, of Glasgow, Scotland. (Ore Mixing and Separating Apparatus.)

A flotation apparatus comprising a mixing chamber and a spitzkasten. The mixing chamber is beneath the level of the spitkasten. Mixing is accomplished by two impellers on the same horizontal shaft coming in through stuffing boxes in the sides of the mixing chamber.

1,064,209. June 10, 1913. James Hebbard, of Broken Hill, New South Wales, Australia. (Apparatus for Ore Concentration.) Assignor to Minerals Separation, Limited, of London, England.

Apparatus for concentrating ores by gaseous flotation of certain mineral particles in liquid, comprising in combination of a series of adjacent mixing vessels, each containing a rotary agitator and a spitzkasten placed contiguous thereto having a high level orifice leading from the first mixing vessel to the spitzkasten, and a low level orifice leading from the spitzkasten to the bottom of the second mixing vessel. Commonly called the single-level valveless machine of the Minerals Separation Company.

1,064,459. June 10, 1913. Francis I. du Pont, of Wilmington, Delaware. (Method of Gravity Liquid Separation of Solids.)

A process of gravity liquid separation of solids, which consists in immersing the solids to be separated in a liquid of greater specific gravity than water, separately removing from the bath the separated constituents of different specific gravity, volatilizing the gravity liquid carried off by each constituent, condensing the same and returning the same to the separating bath and maintaining the circuit of the liquid carried off from the bath by the constituents from its departure from the bath until return to the bath out of connection with the air.

1,064,723. June 17, 1913. Henry Howard Greenway, of Melbourne, Victoria, and Henry Lavers, of Broken Hill, New South Wales, Australia. Assignors to Minerals Separation Limited, of London, England.

A process of concentrating ores, which consists in mixing finely divided ore with water containing as a froth-producer, an essential oil, such as eucalyptus, cinnamon, penny-royal, etc., agitating to insure thorough aeration and separating the froth from the gangue in a spitzkasten attached to the agitating compartments. The Minerals Separation Company claims that this patent reveals methods which allow the elimination of acid and heat in flotation.

1,067,410. July 15, 1913. Francis I. du Pont, of Wilmington, Delaware. (Apparatus for Gravity Lnquid Separation of Solids.)

An apparatus for gravity liquid separation of solids, as described in patent No. 1,064,459, comprising a revolving cylinder adapted to contain the separating liquid, conical ends projecting from said cylinder, an inner peripheral continuous spiral blade in said cylinder, adapted to convey the material that sinks to one end of the cylinder where it is discharged, while the floating material passes to the other end of the cylinder. The adhering liquid is distilled off from the solids and reused.

1,067,485. July 15, 1913. Howard Hoit Nutter, of Berkeley, California, and Henry Lavers, of Broken Hill, New South Wales, Australia. Assignors to Minerals Separation Limited, of London, England.

A process for concentrating ores by which the ore pulp is subjected to repeated treatments by flotation under different conditions—varying the amounts of oil and acid used—the products thus obtained contain different minerals in such a limited range of sizes that they may be further treated on concentrating tables.

1,069,169. August 5, 1913. H. Parker, Nashura, New Hampshire. (Separating Apparatus.) Assignor to Improved Paper Machinery Company, Nashura, New Hampshire.

An apparatus for separating and catching the solid material contained in the waste water from paper making machines. The waste water passes from a supply tank into a second tank, fitted with baffles. If the baffles are used as electrodes and are connected to a battery, the bubbles of hydrogen gas generated attach themselves to the solid particles, thus causing them to rise to the surface in a third or separating tank, where they are skimmed off. Instead of using an electric current for generating gas, the gas may be generated from some outside sources, and is then introduced into the tank.

1,071,784. September 2, 1913. E. H. Nutter, of New York, N. Y. Assignor to Minerals Separation, Limited, London, England.

A valve for controlling the flow of thick pulpy material and the like, comprising a rubber diaphragm, held against the bottom of the discharge pipe from a tank, by predetermined water pressure. When the accumulation of solids in the tank has reached a certain point, their weight is sufficient to press down the diaphragm, and the solids escape until the water pressure closes the valve.

1,071,850. September 2, 1913. Henry E. Wood, Denver, Colorado. (Ore Concentrator.)

A combination Wilfley table and flotation machine, feeding dry ore and collecting floating concentrates by a special device, as well as the regular heavy concentrate of the particles which are too heavy to float.

1,079,107. November 18, 1913. George Albert Chapman and Stanley Tucker, of London, England. Assignors to Minerals Separation Limited, of London, England.

A process for the flotation of ores in which the sulphuric acid commonly used is replaced by a bisulphate of an alkali metal or a combination of a normal sulphate with sulphuric acid, whereby the consumption of sulphuric acid is greatly reduced.

1,080,886. December 9, 1913. Hermann Alexander Brackelsberg, of Hagen, Germany.

A surface tension separator for the flotation treatment of minerals, comprising a number of concentric and conical shaped receptacles adapted to overflow into one another, the overflow walls being at progressively lower levels, and each overhanging the surface of liquid in the next receptacle at an angle adapted to cause a film of liquid to flow along the overhanging surface of said wall, and means for gently feeding the material and liquid across the series of receptacles. The valuable particles overflow into a suitable receptacle, while the gangue sinks to the bottom.

1,081,360. December 16, 1913. Charles Henry Brown, Magdelena, New Mexico. Assignor to the Sherwin-Williams Company, Cleveland, Ohio, a corporation of Ohio.

An apparatus for separating valuable minerals from gangue which is dependent upon the phenomenon of surface tension. The ore is fed upon a conveyor belt which is so arranged as to alternately dip into and out of water contained in a tank. This repeated presenting of the ore to the surface of the water causes the valuable particles to be floated off the belt, the gangue remaining being discharged at the end of the conveyor. Steam pipes are provided for heating the water, as increasing the temperature facilitates the separation.

1,081,949. December 23, 1913. F. I. du Pont, Wilmington, Delaware. (Recovering Separating Liquids from Separated Solids.) Assignor to International Haloid Company.

A process for recovering the heavy liquid carried away by the solids, when using this method of separation. The tin or antimony bromide carried away may be dissolved from the solids by alcohol, and later recovered by distillation; the alcohol distilling off at a temperature below the volatilization point of the bromides.

1,084,196.. January 13, 1914. Walter Broadbridge and Allen Crawford Howard, London, England. (Apparatus for Ore Concentration.) Assignors to Minerals Separation Limited, London, England.

Apparatus for carrying out the agitation-froth process of ore concentration comprising in combination a series of agitating and aerating vessels, a series of spitzkastens contiguous thereto and communicating with a plurality of the said vessels at various points, and partitions between the spitzkastens which do not extend up to the liquid level, so as to leave uninterrupted surface for the formation of the froth. Suitable grids are placed across the discharge openings leading from the agitating cells to the spitzkasten, which serve to break up eddy currents in the froth.

1,084,210. January 13, 1914. A. C. Howard, London, England. Assignor to Minerals Separation, Limited, London, England.

An apparatus for agitating and aerating liquids or pulps, comprising an impeller, fastened to a vertical shaft, with radial blades

curved forward to accelerate the velocity of the pulp, and to create a suction that draws air down into the pulp. Baffles of square bars or expanded metal surround the impeller, and are used to break up the currents, leaving the surface quiet so the froth can float off from the agitating cell.

1,088,050. February 24, 1914. Henry Ellsworth Wood, Denver, Colorado. (Ore-Concentrator.)

An apparatus for the film flotation of ores comprising a settling tank in combination with a rotary drum submerged to near its top and having a longitudinally corrugated surface adapted to present a continuous surface film of water. When ore is fed onto the drum, the valuable minerals float on the film and are gently slid upon the surface of the water in the tank. The floating particles pass to the other end of the tank, where they come in contact with an endless belt to which they adhere and are carried out of the tank to be deposited in a suitable receptacle.

1,093,463. April 14, 1914. Howard Hoyt Nutter, New York, N. Y., and Theodore Jesse Hoover, London, England. (Method and Apparatus for Ore Concentration.) Assignors to Minerals Separation Limited, London, England.

An improved apparatus for the flotation treatment of ores, comprising a number of agitating cells in series, the connecting passages between the cells being provided with baffles so arranged as to deflect and entrap below the surface whatever froth attempts to rise on the liquid. The entrapped froth is removed as desired. The advantage of removing the froth before it reaches the free air surface lies in thus recovering the mineral that would be lost by the bursting of the tender bubbles as soon as they reach the surface, and in the removal of froth as soon as formed, thus preventing over agitation.

1,094,760. April 28, 1914. Joseph T. Terry, Jr., San Francisco, California. (Process for Recovering Metalliferous Constituents of Ores.)

A method of converting carbonate and oxide ores into sulphide form, thus rendering them amenable to treatment by flotation. The ore is preferably wet ground in a ball or tube mill to which hydrogen sulphide gas is admitted, after sulphizing, the pulp passes into a tank in which a vacuum is maintained to remove any surplus gas remaining in the ore. The ore is then treated in any suitable flotation apparatus.

1,098,668. June 2, 1914. Hovland & Frankforter, Minneapolis, Minnesota. (Art of Treating Metalliferous Materials.)

Dry hydrogen sulphide gas will sulphidize metallic copper, its oxides, carbonates and silicates, as well as those of other metals, more rapidly than if gas is in solution. Ore is crushed to 60-mesh or under, and is revolved in a drum to which the gas is admitted, either

under atmospheric or artificial pressure. Ten to twenty minutes is usually a sufficient time for sulphidization. Coarsely crushed ore may be sulphidized, in a similar manner, but a longer time is required.

1,099,699. June 9, 1914. Henry Howard Greenway, Melbourne, Victoria, Australia. (Concentration of Ores.) Assignor to Minerals Separation Limited, London, England.

A modification of process described in patent No. 962,678, consisting in mixing a powdered ore with neutral water containing in solution a minute quantity of an aromatic hydroxy compound, such as phenol, cresol or mixture of the two, agitating the mixture in the cold to form a froth and separating the froth.

1,101,506. June 23, 1914. Leslie Bradford, Broken Hill, New South Wales, Australia. (Process for the Separation of Metallic Sulfids from Gangue and Apparatus therefor.) Assignor, by Mesne Assignments, to Minerals Separation Limited, London, England.

A process of concentrating ores, which consists in mixing the ore with water to form a flowing pulp, adding to the pulp sufficient acid to bring about the evolution of gas by chemical action of the acid, subjecting the pulp and evolved gas therein to violent agitation, and then flowing the agitated pulp away from the place of agitation and separating the floating material. No oil is used. It is advantageous to heat the solution to about 140 degrees F.

1,102,738. July 7, 1914. Henry Howard Greenway, Clare, South Australia, and Alfred Henry Piper Lowery, Prahran, Victoria, Australia.

A process of differential flotation of metalliferous ores, which consists in the addition of a chromium salt, such as sodium or potassium bichromate, to the solution whereby certain sulphides are rendered amenable to flotation, while others are deadened and will not float.

1,102,873. July 7, 1914. George Albert Chapman and Stanley Tucker, London, England. Assignors to Minerals Separation, Limited, London, England.

A process for concentrating ores, which consists in first agitating a quantity of water with a modifying agent, such as cresol or the essential oils, out of contact with the ore so as to form an air emulsion, and thereafter adding to the water the ore to be treated and agitating the same therewith so as to form a froth and separating the froth, resulting in decreasing the amount of frothing agents and acid required and a cleaner concentration of clayey ores.

1,102,874. July 7, 1914. George A. Chapman, London, England. (Ore Concentration.) Assignor to Minerals Separation, Limited, London, England, a corporation of England.

A process for concentrating ores, which consists in grinding the ore with water, in the presence of a modifying agent, such as any of

the essential oils, so that the agent modifies the physical characteristics of the water, and then floating in the usual manner with the addition of a frothing agent.

1,104,646. July 21, 1914. J. D. Fields, Butte, Montana. (Electrolytic Apparatus.)

An improved cell for the electrolytic treatment of ores, especially copper, in which the metal is deposited from solution.

1,104,755. July 21, 1914. John M. Callow, Salt Lake City, Utah. (Ore-Concentrating Apparatus.) Assignor to Metals Recovery Company, Augusta, Maine, a corporation of Maine.

An ore concentrating apparatus having a solution containing tank and a porous body therein through which fine streams of air under pressure are admitted into the solution from below, and a mechanical agitator operating just above the porous bottom in order to prevent the clogging of the pores by the accumulation of sand.

1,106,195. August 4, 1914. Francis I du Pont, Wilmington, Delaware. Assignor to International Haloid Company, a corporation of Delaware.

An apparatus for the separation of solids in liquids of great specific gravity. The combination with a tank adapted to hold the separating liquid having an outlet from which the separated constituent is discharged, of a conveyor, a conduit through which the conveyor travels, means to heat the conduit, a condenser, a pipe leading to the condenser from the conduit at a relatively hot part of the latter, a vapor discharge from the condenser and a pipe leading from the vapor discharge to the conduit at a relatively cool part of the latter, and means to deliver material from the tank outlet to the conveyer, said tank, conduit and condenser being closed against direct connection with the external atmosphere.

1,108,440. August 25, 1914. Edward James Horwood, Broken Hill, New South Wales, Australia. (Separation of Zinc-Blende and other Metalliferous Constituents from Ore Concentrates and Slimes by Flotation or Granulation.)

An improvement over the process described in patent No. 1,020,353, whereby the ore is first subjected to a preliminary wash with pure water, so that the soluble salts are removed before subjecting the ore to the roast. In the subsequent flotation treatment less acid will be required than formerly was necessary.

1,116,642. November 10, 1914. William Sydney Stevens, Magdelena, New Mexico. Assignor, by Mesne Assignments, to The Ozark Smelting and Mining Company, Cleveland, Ohio, a corporation of Ohio.

The process of concentrating ore, which consists in mixing together at a temperature of not less than 60 degrees C., crushed ore,

sufficient water to form a flowing pulp, sulfuric acid not over 5 per cent by weight, and a mineral oil in amount only sufficient to perferentially coat the desired sulfide particles of the ore, not over 1 per cent, generally 3 to .6 per cent; and thereafter presenting the pulp to the air and then to the surface of a liquid to cause a flotation of the oiled sulfid particles by surface tension.

1,124,853. January 12, 1915. John M. Callow, Salt Lake City, Utah. Assignor to Metals Recovery Company, Augusta, Maine, a corporation of Maine.

An ore concentrating apparatus having a solution-containing tank and a porous medium therein through which fine streams of air under pressure are admitted into the solution from below, a mechanical agitator operating in proximity to the upper surface of said medium for beating the air into the solution and maintaining the heavier constituents of the solution in suspension to thereby prevent the blanketing of the air outlets of said porous medium and suitable discharge openings for the froth and tailing.

1,124,854. January 12, 1915. J. M. Callow, Salt Lake City, Utah. Assignor to Metals Recovery Company, Augusta, Maine. (Rotary Mixing Drum.)

An apparatus for effecting the intimate mixing of water, finely divided ore and oil, comprising a rotating drum provided with an outer and inner shell, the space between the shells being divided into compartments, into which air or other gas may be introduced under pressure. The inner shell is porous to permit the passage of the air or gas into the interior of the drum. Suitable blades are fastened to the inner shell to assist in agitating the pulp and in conveying it through the drum when it is being fed in at one end and discharged at the other end.

1,124,855. January 12, 1915. John M. Callow and David J. Kelly, Salt Lake City, Utah. Assignors to Metals Recovery Company, Augusta, Maine, a corporation of Maine. (Ore-Separatory Apparatus.)

An apparatus of the combination with a tank adapted to contain a mixture of powdered ores and water and a frothable agent, of a hollow rotary member operable in the tank and adapted to receive a gaseous fluid under pressure, said member being sufficiently porous to permit the passage of the gaseous fluid therethrough but not the water and pulp.

1,124,856. January 12, 1915. John M. Callow, Salt Lake City, Utah. Assignor to Metals Recovery Company, Augusta, Maine, a corporation of Maine. (Ore-Flotation Apparatus.)

An apparatus having a pulp-containing tank and a porous body therein through which streams of gaseous fluid under pressure are admitted into the solution from below, said porous body permitting the passage of the gaseous fluid but not pulp and water, and a re-

ciprocable carrier mounted in the tank and having elements operating in proximity to the upper surface of said body for maintaining the coarser constituents of the solution in suspension to thereby prevent the blanketing of the outlets of said porous body.

1,125,897. January 19, 1915. John M. Callow, Salt Lake City, Utah. Assignor to Metals Recovery Company, Augusta, Maine, a corporation of Maine. (Process of Concentrating Ores.)

Apparatus for separating the metalliferous from the non-metalliferous ingredients of an ore mass, the combination of a pulp receptacle, means for forcing substantially uniformly distributed bubbles to the surface of said mass, and independent means for exhausting said bubbles from the upper surface of the pulp.

1,126,965. February 2, 1915. Joseph W. Emerson, Salida, Colorado. (Process of Treating Ores.)

The process of removing blende from blende-containing concentrates which comprises submerging a body of such concentrates in a relatively deep body of an acid solution, mechanically engaging said particles as soon as they rise above the general plane of such body of concentrates and immediately removing them from the acid solution, by means of a drag conveyor, the settled tailing being removed by another conveyor.

1,134,690. April 6, 1915. Bernard MacDonald, Los Angeles, California. (Apparatus for Separating Minerals by Flotation.)

An apparatus for separating minerals by flotation comprising a receptacle, a launder adjacent to the receptacle into which the material passes from the receptacle, a vertically disposed transfer-pipe within the receptacle having a lower open intake end and an upper discharge end, a pipe entering the lower open end of the transfer-pipe, means for supplying compressed air to said last mentioned pipe and means for supplying oil to said last mentioned pipe. An adaptation of the Parral Tank to flotation.

1,136,485. April 29, 1915. Charles E. Rork, Douglas, Arizona. (Flotation Machine.)

A flotation apparatus comprising a horizontal shaft to which several paddle wheel agitators are fastened, each working in a separate chamber. The agitators splash the pulp out through a discharge opening near the top of each chamber, into a common settling tank, from which the floating mineral is recovered, while the gangue sinks and is drawn into the bottom of the next agitating chamber. This process is repeated until the tailing is discharged from the last chamber.

1,136,622. April 20, 1915. Benjamin Sedgely Smith, Sydney, New South Wales, Australia. (Apparatus for the Wet Dressing of Sulfid Ores.)

In combination, a surface tension separating table provided with means for flowing liquid therethrough, a screen thereover adapted to

deliver a predetermined size of material to the table, a distributing screen close to and parallel with the surface of the liquid on the table, interposed in the path of material dropping from the primary screen and adapted to break the momentum thereof.

1,140,865. May 25, 1915. R. F. Bacon, Pittsburg, Pa. Assignor to Metals Research Company, New York, N. Y.

A process for the flotation treatment of ores, whereby colloidal sulphur is used to separate the mineral from the gangue. The finely divided ore is introduced into water containing a soluble sulphide, such as hydrogen sulphide, in solution. A reagent is then introduced which will react with the soluble sulphide to produce colliodal sulhpur, sulphur dioxide is a satisfactory reagent. It is of advantage to use sufficient sulphur dioxide to make the solution faintly acid. In order to assist the flotation of the mineral, air may be introduced into the bottom of the flotation tank. In general it is not necessary to use oil or employ mechanical agitation, as the colloidal sulphur alone is able to effect the desired separation.

1,140,866. May 25, 1915. Raymond F. Bacon, Pittsburg, Pennsylvania. Assignor to Metals Research Company, New York, N. Y.

A method of sulphidizing oxidized ores to render them amenable to flotation whereby hydrogen sulphide gas is used to sulphidize the ore. Any excess of hydrogen sulphide in the pulp is then neutralized with sulphur dioxide, and the solution is rendered slightly acid before passing to the flotation machine. By this means an improved recovery of the sulphides is accomplished. Some ores give better separation if the solution is neutral or alkaline.

1,141,377. June 1, 1915. John M. Callow, Salt Lake City, Utah. Assignor, by Mense Assignments, to Metals Recovery Company, a corporation of Maine.

An apparatus comprising a number of agitating tanks, provided with porous bottoms for the admission of air. Agitation is accomplished solely by air, no mechanical device being employed. Said tanks are arranged in series so that the tailing from one tank becomes the feed to the second tank and so on. A common overflow launder catches the froth, which may be sent to other tanks for further cleaning. Provision is made for adding oil and acid to the pulp, before feeding it to the tanks.

1,142,821. June 15, 1915. Henry Lavers, Surrey Hills, Victoria, Australia. Assignor to Minerals Separation, American Syndicate, (1913), Limited, London, England.

A process of differential flotation of metallic sulfid ores, which consists in subjecting the ore to the action of a chromium salt in a slightly alkaline solution and to a flotation separation in a heated circuit whereby a flotation product relatively high in certain sulfids and a residue relatively high in other sulfids are abtained.

1,143,797. June 22, 1915. Gunnar Sigge Andreas Appelqvist and Einar Olof Eugen Tyden, Stockholm, Sweden. (Process of Separating the Constituents of Rocks.)

The process of separating constituents of rocks by the aid of oils which consists in treating the material to be separated in the form of a powder in dry condition with oils gasified by the application of heat, repeating at will the said treating operation, immersing the material thus treated into a liquid, agitating the mass, and allowing the different particles to separate from one another.

1,147,633. July 20, 1915. Archibald R. Livingston, Canon City, Colorado. (Concentration of Minerals by Flotation.) Assignor to the New Jersey Zinc Company, New York, N. Y., a corporation of New Jersey.

The method of separating floatable minerals from material with which they are associated, which consists in feeding the mixture into the body of water, contained within a rotating hollow cylinderical vessel which is provided with small short studs projecting out from the inner periphery of said cylinder, progressively raising it through the surface of the water at an angle greater than its natural angle of repose, washing down the emerging top layer by a jet of water, and floating the top layer thereby into the main body of water at the surface thereof and collecting the material thereby separated from that which sinks.

1,151,117. August 24, 1915. Arthur J. Moxham, Wilmington, Delaware. (Ore Separating Process.)

A process of separating solid constituents of different specific gravities in a heavy liquid, first treating the solids to reduce the specific gravity of each of the solid constituents to the extent required to cause the separating liquid to have the desired specific gravity relative to the specific gravity of each of the solid constituents, and then effecting the separation of the solid constituents in such separating liquid.

1,155,815. October 5, 1915. Arthur Howard Higgins and William Warwick Stenning, London, England. Assignors to Minerals Separation, Limited, London, England.

Apparatus for concentrating ores by gaseous flotation of certain mineral particles in liquid, comprising, in combination, a vessel, means for introducing a gas therein at the lower part of the vessel, means for producing a zone of violent agitation and gasification in the lower part of the vessel, a baffle above the agitator for producing a quiescent zone in the upper part of the vessel, the baffle being inclined downwardly from the inlet side to the outlet side of the vessel, an inlet for the pulp to the vessel below the baffle, means for removing the froth from the upper surface of the liquid, and an outlet for the residues above the baffle.

1,155,816. October 5, 1915. A. H. Higgins, London, England. Assignor to Minerals Separation Company.

An apparatus for the flotation treatment of ores, comprising a single chamber for both the agitating of the pulp and the removal of the froth formed. The lower part of the chamber contains the mechanical agitator and pipes for the separate admission of compressed air and pulp. The upper part of the chamber is provided with a series of baffles which serve to bring the liquid to a state of comparative rest, so that the bubbles may rise to the surface, forming a froth that escapes through a peripheral overflow at the top. A suitable discharge opening is provided for the tailing.

1,155,836. October 5, 1915. Thomas Mackellar Owen, Broken Hill, New South Wales, Australia. Assignor to Minerals Separation, American Syndicate, (1913), Limited, London, England.

An apparatus for concentrating ores by gaseous flotation of certain mineral particles in liquid, a single upright vessel open at the top comprising both an agitation and a separation vessel, an inlet conduit for ore pulp at the bottom of the vessel, an outlet conduit for tailings near the top of the vessel, a rotable agitator in the lower part of the vessel, a conduit for air leading into the lower part of the vessel, vertically elongated baffles immediately above the agitator terminating at a substantial distance below the surface of the liquid in the vessel for producing a baffling zone above the atomizing zone, and a substantially quiescent topmost and separating zone above the baffling zone.

1,155,861. October 5, 1915. Louis Albert Wood, London, England. Assignor to Minerals Separation, American Syndicate, (1913), Limited, London, England.

A process of concentrating ores which consists in subjecting the powdered ore suspended in water free from frothing agents to the admission of gas, by a mechanical agitator, disseminating the gas through the pulp in such a way that the gaseous bubbles preferentially attach themselves to certain mineral particles, and rise toward the surface and discharge their mineral load with the pulp, and catching and removing such discarded mineral below the surface of the liquid.

1,156,041. October 5, 1915. G. C. Stone, New York, N. Y. Assignor to New Jersey Zinc Company, of New York, N. Y.

An apparatus for concentrating minerals by flotation, comprising a tank having an overflow opening for collecting the floating minerals, and a bottom discharge gate for drawing off the settled gangue. The crushed ore is delivered from a bin to a carrier by an automatically operated gate. The carrier consists of a number of short, shallow parallel troughs fastened together. After receiving its load, the carrier moves down into the liquid in the tank in a direction nearly parallel with the surface of the liquid. The load is discharged and the carrier returns for another load. The ore thus being presented to the separating liquid in a series of fine streams and in a manner to create the least possible agitation is acted upon to the best advantage.

1,157,176. October 19, 1915. Thomas Mackellar Owen, Sydney, New South Wales, Australia. Assignor to Edward William Culver, Sydney, New South Wales, Australia.

A process of preferential froth flotation separation of metallic sulfids from slimes, by augmenting the floative quality of certain sulfids in relation to certain other sulfids, by adding to and agitating with the pulp a limited proportion of alkaline permanganate.

1,159,713. November 9, 1915. Lewis G. Rowand, Brooklyn, N. Y. Assignor to New Jersey Zinc Company, New York, N. Y., a corporation of New Jersey. (Separation of Minerals by Flotation.)

The method of separating sulfids constituents from ores in which they are contained, which comprises feeding the solid particles of the ore in a finely divided condition upon a moving belt having on its surface a thin layer of oil, progressively feeding said layer with its charge of ore into a flotation liquid at the surface thereof, and floating off and recovering the floating sulfids.

1,159,942. November 9, 1915. H. B. Hovland, Duluth, Minnesota. (Method of Sulphidizing Metals.)

A process of sulphidizing metals, whereby the metal is first brought into solution in a suitable solvent and is then precipitated as a sulphide. As an example, an oxidized ore of copper is treated with sulphuric acid to dissolve the copper, which is then precipitated by the addition of calcium sulphide and ferric sulphate. The ferric sulphate facilitates greatly the action of the calcium sulphide.

1,162,291. November 30, 1915. M. Kraut, Bisbee, Arizona. (Feeding Mechanism.)

An apparatus for providing a uniform and regular feed of oil, acid or other liquid to a flotation machine, comprising a revolving cylinder, partly immersed in the liquid to be used, and a scraper so arranged as to remove any desired amount of the liquid from the face of the drum or cylinder as it revolves.

1,167,076. January 4, 1916. T. A. Janney, Garfield, Utah. (Ore-Concentrating Apparatus.)

An apparatus for treating ores by the flotation process, comprising an agitating chamber; a vertical shaft having agitating blades attached near the bottom and directly connected at the top, to an electric motor; and a spitzkasten into which the pulp flows from the agitator, and in which the separation of the floating mineral from the gangue takes place.

1,167,835. January 11, 1916. D. H. Norris, San Francisco, California.

An apparatus for separating the metallic and rocky constituents of ores, comprising a long vertical cylinder provided with a central feed pipe and a peripheral overflow at the top, and a discharge pipe at the bottom. At intervals along the cylinder openings are made and perforated pipes are introduced for the purpose of admitting air or

aerated liquor to the interior. The ore pulp is fed in at the top, and floating particles pass out through the peripheral overflow, while the gangue sinks and is discharged at the bottom.

1,170,637. February 8, 1916. E. A. Higgins, London, England. Assignor to Minerals Separation, Limited, London, England.

A froth flotation process in which a class of compounds, never before used, is employed as a frothing agent. These compounds are the products derived from the treatment of organic bodies, such as oils, fats, alcohols, penols, etc., with sulphuric acid, and are known as "soluble oils."

1,170,665. February 8, 1916. E. H. Nutter, San Francisco, California. Assignor to Minerals Separation, Limited, London, England.

A process of froth flotation, in which certain hydrocarbon frothing agents are treated with sulphuric acid, the products forming a cleaner concentrate and a more stable froth than the untreated frothing agents. The hydrocarbons used are those obtained in the treatment and refining of petroleum, kerosene, gas tar and the like, particularly in the refining of their distillates.

1,174,737. March 7, 1916. F. B. Kollberg and M. Kraut, Bisbee, Arizona. (Flotation Machine.)

A flotation machine comprising a long rectangular agitating chamber, in which a drum, provided with a series of longitudinal riffles on its face, rotates at a suitable speed. The ore and water are fed into the agitating chamber at such a rate as to keep the drum only slightly submerged in the pulp. Oil is added through oil supply pipes. The revolving drum picks up a thin layer of pulp, which is thrown off tangentially by centrifugal force in the form of a fine spray, thus receiving excellent aeration, and is discharged through a suitable opening into a separating chamber or spitzkasten, where the froth is separated from the gangue. Additional aeration of the pulp is secured from air that enters the interior of the drum, and is forced out into the pulp through perforations in the face of the drum.

1,176,428. March 21, 1916. John M. Callow, Salt Lake City, Utah. Assignor to Metals Recovery Company, Augusta, Maine. (Flotation Separatory Apparatus and Process.)

The application of vacuum to the upper surface of what is commonly known as a "Callow Cell" to draw air through the porous bottom for purposes of frothing. The froth runs into a chamber from which the air is trapped out.

1,176,441. March 21, 1916. Ernest Gayford and George Crerar, Salt Lake City, Utah. Assignors to Metals Recovery Company, Auguta, Maine. (Process of Concentrating Ores.)

Process of alternate crushing and flotation, in steps, of an ore, one advantage being in not sliming the desired minerals excessively.

(This Index was prepared by Prof. Hallet R. Robbins, Professor of Mining, Washington State College.)

INDEX TO PATENTS

The Metallurgical Research Department

Of the State School of Mines was established by the Legislature in 1913. This Department was established for "finding ways and methods of profitably treating low grade ores, of securing a higher percentage of extraction of metals from their ores, for obtaining other information that shall have for its object the benefit of the mining industry and utilization and conservation of the mineral resources of the state and for the publication and distribution of bulletins," etc.

By an agreement with the United States Bureau of Mines the work of this Department is under the direction of Metallurgists of the Bureau assigned to duty with headquarters at the University of Utah.

During the fiscal year 1915-1916 the following problems have engaged the attention of this Department:

1. A study of the flotation processes in order to determine their applicability to the treatment of ores that are not at present being treated by such processes, especially the low-grade lead carbonate ores of Utah.

2. The hydrometallurgical treatment of low-grade and complex lead ores.

3. The treatment of carbonate ores of zinc, especially with reference to the hydrometallurgical and igneous concentration processes.

4. A study of the effects of roasting on complex zinc-lead-iron-sulphide mixtures, with especial reference to the solubility of the various constituents of the ore after roasting.

5. Electrolytic deposition of lead and zinc from their solutions.

6. Cyaniding of refractory silver ores with especial reference to aluminum as a substitute for zinc in precipitating gold and silver from cyanide solutions.

7. Losses in milling processes.